

LTBB Surface Water Quality Program



Baseline Assessment Report

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Please Note: These assessments, methods, and standards to determine water quality are subject to change as the Surface Water Quality Protection Program, collaboration, information, technology, methods, assessments, and Tribal needs, management decisions, and land base evolves.

Purpose/Description of LTBB 106 Clean Water Act Program

In the year of 2000, the LTBB Surface Water Quality Protection Program established a monitoring program to collect baseline data to assess current water quality conditions. Current water quality conditions can only be assessed by collecting long term data on a consistent basis. Water quality assessment measures the suitability of water for Tribal uses based on selected physical, chemical, and biological characteristics.

LTBB draft Tribal uses are defined in Appendix 1 and are usages of LTBB surface waters by the Tribal community, aquatic life and/or wildlife, and for the prosperity of our natural resources. These Tribal uses and definitions are draft and are solely defined by the judgment of the LTBB Water Quality Specialist and are considered preliminary. Note: These Tribal Uses in Appendix 1 have been finalized and revised since this assessment. Therefore, the titles and definitions may vary from the document in Appendix 1 and the document titled LTBB Draft Tribal Uses. LTBB Draft Tribal Uses is the document we are seeking review on from the LTBB community.

This baseline assessment will assist in determining the best approach for LTBB to pursue protection efforts for Tribal surface waters within the reservation boundaries and/or surface waters directly affecting reservation waters. LTBB's citizenship consists of 4,489 Tribal citizens as of March 10th, 2011, with over one thousand living in and around the delineated reservation. Environmental protection and sustainability of our Tribal Nation's natural resources is of high priority to these Tribal citizens and government. As a Great Lakes Nation covering 336 square miles, LTBB citizens rely on these waters in perpetuity. Please see Figure 1 for an inventory of LTBB water resources.

Atlas Table (Inventory of Tribal Water Resources)	
Factor/Resource	Value
Surface Area of Tribal Lands (Acres)	216,749
Total number of enrolled LTBB Tribal Citizens (Updated March 10 th , 2011)	4489
Total miles of rivers and streams on Tribal Lands	394
Number of chemical and physical monitoring points on rivers or streams (Number based on active sites monitored as of September 30, 2010)	19*
Number of lakes/reservoirs/ponds on Tribal Lands	232
Acres of lakes/reservoirs/ponds on Tribal Lands	7,987
Number of chemical and physical monitoring points on lakes/reservoirs/ponds (Number based on active sites monitored as of September 30, 2010)	17
Acres of wetlands (including coastal)	35,647
Number of functional and culturally monitored wetlands	12
Miles of Great Lakes shoreline	110
* An amendment was completed in July 2004 to include seasonal monitoring on three Boyne River sites for physical parameters only. These sites are included in this total.	

Figure 1: Atlas Table (Inventory of Tribal water Resources)

Surface Water Quality Program Monitoring Methods

The LTBB baseline monitoring design identifies all fixed baseline monitoring sites at specific water bodies within and adjacent to the delineated reservation. These fixed sites have been monitored on a biennial basis over a ten year time period with data collected monthly May through October. In 2008, winter sampling was amended into the workplan as an additional monitoring event to the baseline schedule. Collection of data in the winter was approved at all fixed sites that are deemed safe and accessible in the winter weather conditions. Water bodies monitored in odd years were: Lake Charlevoix, Larks Lake, Crooked Lake, Spring Lake, Susan Lake, Brush Creek/Maple River, Susan Creek, and Big Sucker Creek. Water bodies monitored in even years were: Walloon Lake, Round Lake, Wycamp/Spirit Lake, O'Neal Lake, Little Traverse Bay (Bay of Lake Michigan), Five Mile Creek, Tannery Creek, Wycamp Creek, and Bear River. The Boyne River was monitored seasonally every year for physical parameters only. A map of the LTBB baseline monitoring sites is available in the Maps folder as Map 1. Figure 2 includes the years monitored, GPS coordinates, WQX/CDX site identification codes, and access roads for each water body.

Water body Name	Site ID	Access Roads	GPS Coordinates		Years Monitored
		*Access Road or location of site w/in a water body	Latitude	Longitude	May - October (unless stated otherwise).
Bear River	BR1	Mineral Park	45° 22' 20.9712"	84° 57' 40.2444"	Even 2000, 2002, 2004, 2006, 2008, 2010
	BR2	McDougal Road	45.20'24	84.56'13	
	BR3	Springvale Road	45.15'44	84.53'49	
Big Sucker Creek	BSC1	Ellis Road	45.42'45.0648	84.54'17.1829	Odd 2001, 2003, 2005, 2007, 2009
	BSC2A	Wilderness State Park	45° 44' 10" N	84° 56' 8" W	
Boyne River	BNR1	Boyne City Park	45° 12' 52" N	85° 0' 43" W	Seasonal - February, May, August, November
	BNR2	Dam Road	45° 11' 48" N	84° 57' 28" W	
	BNR3	M-75, Boyne Falls	45° 10' 10" N	84° 55' 3" W	
Brush Creek/Maple River	BCMR1	U.S. 31 South, Maple River	45° 32' 24.2087"	84° 47' 0.3011"	Odd 2001, 2003, 2005, 2007, 2009
	BCMR2	Ely Bridge Road, Maple River	45.34.45	84.51.11	
	BCMR3	Van Road, Brush Creek	45.35.38	84.54.50	
Lake Charlevoix	CXL1	Lake Charlevoix, Ironton Fairy	45° 14' 16.6380"	85° 10' 8.2308"	Odd 2001, 2003, 2005, 2007, 2009
	CXL2	Lake Charlevoix, N. arm	45° 15' 56.0196"	85° 5' 28.4532"	
Crooked Lake	CDL	MDNRE launch, SE	45° 24' 44.9280"	84° 49' 52.9032"	Odd 2001, 2003, 2005, 2007, 2009
Five Mile Creek	FMC1	Lower Shore Drive	45° 27' 56.8728"	85° 4' 29.6256"	Even 2000, 2002, 2004, 2006, 2008, 2010
	FMC2	Cummings Lane	45° 28' 11.3232"	85° 4' 9.9228"	

Larks Lake	LSL	Kaz Road	45° 36' 34.5095"	84° 55' 43.2515"	Odd 2001, 2003, 2005, 2007, 2009
Little Traverse Bay	LTB1	Breakwall	45.22'56	84.58'07	Even 2000, 2002, 2004, 2006, 2008, 2010
	LTB2	Petoskey State Park	45.23'40	84.57'03	
O'Neal lake	OLL	Ellis Road	45° 42' 45.6264"	84° 53' 46.5864"	Even 2000, 2002, 2004, 2006, 2008, 2010
Round Lake	RDL	Powers Road	45° 24' 16.4808"	84° 53' 32.6904"	Even 2000, 2002, 2004, 2006, 2008, 2010
Spring Lake	SGL1	Spring Lake Park	45° 23' 34.5732"	84° 54' 23.6521"	Odd 2001, 2003, 2005, 2007, 2009
	SGL2	Konle Road	45° 23' 41.4420"	84° 54' 11.8225"	
Susan Creek	SNC1	U.S. 31 South	45.21.33	85.11.00	Odd 2001, 2003, 2005, 2007, 2009
	SNC2A	Taimi Hoag Natural Area	45° 21' 2" N	85° 10' 46" W	
Susan Lake	SNL	Shrigley Road	45° 19' 42.0312"	85° 10' 50.8692"	Odd 2001, 2003, 2005, 2007, 2009
Tannery Creek	TYC1	Glen's North	45° 23' 31.1316"	84° 55' 3.1619"	Even 2000, 2002, 2004, 2006, 2008, 2010
	TYC2A	Kevin Cronk's Property	45.22.31	84.54.04	
Walloon Lake	WNL2	Gruler Road, N. arm	45.17'48	84.58'15	Even 2000, 2002, 2004, 2006, 2008, 2010
	WNL3	Basin 3	45.16'44	85.00'42	
	WNL5	Mud Lake Basin	45.20'42	85.03'09	
Wycamp Creek	WPC1	Chippewa Road	45° 39' 1.8109"	85° 1' 3.3888"	Even 2000, 2002, 2004, 2006, 2008, 2010
	WPC2	Wycamp Road	45° 39' 14.4253"	84° 59' 46.5035"	
Wycamp Lake	WPL	Wycamp Road	45.39.35	84.57.46	Even 2000, 2002, 2004, 2006, 2008, 2010

Figure 2: Sites, site identification codes, access location, GPS coordinates, and years sampled.

Water quality sites (except for the Boyne River) are monitored for twelve physical/chemical parameters, which include dissolved oxygen, conductivity, pH, temperature, total phosphorus (TP), total nitrogen (TN), chloride, total suspended solids (TSS), velocity/discharge rates, depth, water clarity, and chlorophyll *a*. Chlorophyll *a* and clarity are only recorded on lakes, while velocity and total suspended solids are only recorded on rivers, stream, and creeks. Data collected at the Boyne River only include velocity/discharge rates, dissolved oxygen, conductivity, pH, and temperature.

Dissolved oxygen, pH, temperature, conductivity and depth readings are taken utilizing a

Hach Hydromet Sonde. Total nitrogen, phosphorus, suspended solids, and chloride results are gathered by collecting water samples. Water samples collected for total nitrogen and phosphorus are analyzed by Great Lakes Environmental Center (GLEC) and water samples collected for chloride and total suspended solids are analyzed by the LTBB Lab Technician. If the chloride sample is known to be over 25 mg/L it is sent to GLEC because diluting the sample in-house will decrease accuracy. Field/lab precision and procedures are quality assured by collecting field duplicates and blanks for every 10% of samples taken. GLEC and LTBB data results are checked by performing relative percent calculations on duplicates/triplicates and the average of these duplicates/triplicates are accepted for analysis if it passes + or - 15%. Physical parameters are checked for errors by the LTBB Water Quality Specialist (WQS) or Assistant (WQA). During the field season, the Hach Hydromet Sonde(s) are calibrated and maintained according to the manufacturer's instructions. Water bottles are supplied by both labs and bottles are acid washed.

On lakes, baseline water quality sites were established in one of the deep areas of each lake basin. If the lake has more than one basin that is unique in physical characteristics and/or parameter results, those basins are monitored as well. At lakes that are ten feet or deeper, water samples and Sonde measurements are collected at the surface, mid, and bottom depths of the vertical profile. If the lake experiences mixing and/or stratification, Sonde measurements are taken every 2 meters vertically to determine the thermocline. If the lake is less than ten feet deep, water samples and Hach Sonde measurements are taken only at mid depth.

On creeks and streams, there are two water quality baseline sites. Each creek or stream has a fixed site at the mouth and at the origin. On rivers, the same applies, except there is an additional monitoring site approximately in the middle of these two sites due to extended geographical coverage. Creeks, rivers, and streams are monitored using the Equal Width Increment Method. This method determines the cross section width and then measures or collects water samples every 2 feet within the cross section width. Water is collected in a one gallon jug every 2 feet and then the sample is shaken before every pour into the water bottles. Velocity readings are also taken using the same width method and discharge is calculated.

Macroinvertebrates are collected at fixed baseline sites and have been used to determine diversity, percentage of specific orders, and percentage of specific family within orders. Collection of aquatic macroinvertebrates occurs in May of every field season. Lakes have five grab sites where collection occurs in different sediment substrates in the littoral zone. Grabs are collected using an Ekman bottom sampler.

Rivers, streams, and creeks have three kick sites within the 100 meter reach of each baseline water monitoring site. These kick sites are in riffle areas unless riffles are absent. If riffles are absent then grab sites have been chosen by substrate types. Collection is accomplished by using a kick-net or dip net depending on the velocity of each lotic system. Substrate components within the site are kicked into the net and then gathered into bottles containing 95% ethanol. The ethanol preserves the sample until the sample can be sorted at a later date.

The sampling methods described for the macroinvertebrate study allows a holistic approach to represent all types of habitat present at each water body. With fixed sites, results can be compared year by year to measure if an increase or decrease in perturbation over time.

Macroinvertebrate samples are sorted utilizing a random sampling method with a target reach of 100 organisms. Human bias can occur if the sorter only sorts out the larger organisms to reach their target. Random sampling decreases this bias. Random sampling is done by choosing numbers off of a random number chart and then only sorting those numbers that correspond to one inch by one inch grids. Once all samples are sorted within a field season, they are contracted out for identification to genus level. Each entomologist has their own methods and reference

material to identify to genus level. All contracted entomologists submit 10% of their identified aquatic macroinvertebrates to another entomologist for quality assurance purposes. These methods and reference materials are available upon request. Sorting, identification, and calculation of metrics are a long and extensive process. Reporting on aquatic macroinvertebrates is always one 106 Water Quality Assessment Report behind. Due to restructuring of our Department, staff over turn, and time constraints only results through 2007 will be included in this report. 2008 will be included with the 2009/2010 results in the next 106 Water Quality Assessment Report.

In July, qualitative habitat assessments are conducted at water bodies where the assessment is deemed to be representative. The protocol used on streams, creeks, and rivers is from EPA Rapid Bioassessment Protocols Second Edition. Forms 2 and 3 of the Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers Field Data Sheets are used depending on the determination of whether or not the stream, creek, or river is of high or low gradient. This determination was concluded at the beginning of the baseline assessment. Habitat is assessed by observing the 100 meter reach within an area on a lotic system using the fixed water quality site as the reference point. The habitat assessment form for lakes is an EPA & LTBB modified habitat assessment that originally came from the "Lake and Reservoir Bioassessment and Biocriteria Technical Guidance Document" EPA 841-B-98-007, August 1998.

Surface Water Quality Program Assessment

Parameter results are analyzed to determine whether or not each LTBB draft primary/designated uses are fully supported, partially supported, not supported, or need further evaluation. If the LTBB draft primary or designated use is listed as needs "further evaluation" this condition will be a result of insufficient data, not enough information to make a determination, or not having threshold values for those uses in question. For example, Michigan Department of Natural Resources and the Environment (MDNRE) does not have wild rice areas or subsistence fishery as designated uses therefore, these uses may need further evaluation since there are not criteria for assessment. These types of concerns or issues will be described in the narrative summary for each waterbody. The evaluation of the assigned degrees of support based on the LTBB preliminary draft uses were decided solely by the data analysis conducted by the LTBB Water Quality Specialist (WQS). LTBB do not have established Tribal uses or water quality standards at this time, so these uses have not been certified by the EPA nor have they been approved by the LTBB Natural Resource Commission and Tribal Council. LTBB primary/designated draft uses assigned to each water body as well as the evaluation of the degree support based on use are available in Appendix 2 titled Degree of Use Support.

Lakes tested for *E. coli* bacteria by the Northwest Michigan Community Health Agency (NMCHA) are identified in the narrative summaries of this report. Results can be found on this website: <http://www.deq.state.mi.us/beach/>. The criteria used to assess exceedences according to the information provided on the hyperlink are as follows: "*The Michigan Department of Community Health and the Michigan Department of Environmental Quality used guidance provided by the EPA to develop ambient standards for E. coli. E. coli standards for water used for total body contact recreation are provided in the Michigan Public Health Code and Rule 323.1062(1) of the Part 4. Water Quality Standards (Promulgated pursuant to Part 31 of the Natural Resources and Environmental Protection Act, 1997 PA 451, as amended). R 323.1062(1) states, 'All waters of the state protected for total body contact recreation shall not*

contain more than 130 Escherichia coli (E. coli per 100 milliliters (ml), as a 30-day geometric mean. Compliance shall be based on the geometric mean of all individual samples taken during five or more sampling events representatively spread over a 30-day period. Each sampling event shall consist of three or more samples taken at representative locations within a defined sampling area. At no time shall the water of the state protected for total body contact recreation contain more than a maximum of 300 E. coli per 100 ml. Compliance shall be based on the geometric mean of three or more samples taken during the same sampling event at representative locations within a defined sampling area”

The LTBB Environmental Services staff have identified lakes that would benefit from testing that are not currently monitored for *E. coli* bacteria and are identified in this report. The WQS met with a NMCHA staff member about the possibility of collaborating in monitoring at these lakes identified. Collaboration has not been pursued at this time. The LTBB Lab Technician has the expertise to do the analysis in the LTBB Water Quality Lab. However, there are minimal waterbodies that would benefit from the addition of *E. coli* testing, and the cost of additional equipment, sample holding times, and financial constraints outweigh the implementation of an *E. coli* LTBB in-house analysis.

Water quality criteria from the Michigan Department of Natural Resources and the Environment (MDNRE) Part 31 of the Natural Resources and Environmental Protection Act, 1994 PA 451 (as amended) Administrative Rules Part 4 Water Quality Standards for chloride (Dissolved Solids); part 2 of Rule 51, Hydrogen Ion Concentration (pH), Taste- or odor-producing substances, dissolved oxygen, are utilized to evaluate a degree of support for each LTBB waterbody based on draft Tribal uses if applicable. These rules that have been excerpted from the MDEQ Water Quality Standards are as follows:

*DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER BUREAU
WATER RESOURCES PROTECTION
PART 4. WATER QUALITY STANDARDS*

R 323.1053 Hydrogen ion concentration.

Rule 53. The hydrogen ion concentration expressed as pH shall be maintained within the range of 6.5 to 9.0 S.U. in all surface waters of the state, except for those waters where the background pH lies outside the range of 6.5 to 9.0 S.U. Any requests to artificially induce a pH change greater than 0.5 S.U. in surface waters where the background pH lies outside the range of 6.5 to 9.0 S.U., shall be considered by the department on a case-by-case basis.

R 323.1055 Taste- or odor-producing substances.

Rule 55. The surface waters of the state shall contain no taste-producing or odor-producing substances in concentrations which impair or may impair their use for a public, industrial, or agricultural water supply source or which impair the palatability of fish as measured by test procedures approved by the department.

R 323.1051 Dissolved solids.

Rule 51. (1) The addition of any dissolved solids shall not exceed concentrations which are or may become injurious to any designated use. Point sources containing dissolved solids shall be considered by the commission on a case-by-case basis and increases of dissolved solids in the waters of the state shall be limited through the application of best

practicable control technology currently available as prescribed by the administrator of the United States environmental protection agency pursuant to section 304(b) of Public Law 92-500, as amended, 33 U.S.C. §466 et seq., except that in no instance shall total dissolved solids in the waters of the state exceed a concentration of 500 milligrams per liter as a monthly average nor more than 750 milligrams per liter at any time, as a result of controllable point sources.

(2) The waters of the state designated as a public water supply source shall not exceed 125 milligrams per liter of chlorides as a monthly average, except for the Great Lakes and connecting waters, where chlorides shall not exceed 50 milligrams per liter as a monthly average. s measured by test procedures approved by the department.

R 323.1064 Dissolved oxygen in Great Lakes, connecting waters, and inland streams.

Rule 64. (1) A minimum of 7 milligrams per liter of dissolved oxygen in all Great Lakes and connecting waterways shall be maintained, and, except for inland lakes as prescribed in R 323.1065, a minimum of 7 milligrams per liter of dissolved oxygen shall be maintained at all times in all inland waters designated by these rules to be protected for coldwater fish. In all other waters, except for inland lakes as prescribed by R 323.1065, a minimum of 5 milligrams per liter of dissolved oxygen shall be maintained. These standards do not apply for a limited warmwater fishery use subcategory or limited coldwater fishery use subcategory established pursuant to R 323.1100(11) or during those periods when the standards specified in subrule (2) of this rule apply.

(2) Surface waters of the state which do not meet the standards set forth in subrule (1) of this rule shall be upgraded to meet those standards. The department may issue permits pursuant to R 323.2145 which establish schedules to achieve the standards set forth in subrule (1) of this rule for point source discharges to surface waters which do not meet the standards set forth in subrule (1) of this rule and which commenced discharge before December 2, 1986. For point source discharges which commenced before December 2, 1986, the dischargers may demonstrate to the department that the dissolved oxygen standards specified in subrule (1) of this rule are not attainable through further feasible and prudent reductions in their discharges or that the diurnal variation between the daily average and daily minimum dissolved oxygen concentrations in those waters exceeds 1 milligram per liter, further reductions in oxygen-consuming substances from such discharges will not be required, except as necessary to meet the interim standards specified in this subrule, until comprehensive plans to upgrade these waters to the standards specified in subrule (1) of this rule have been approved by the department and orders, permits, or other actions necessary to implement the approved plans have been issued by the department. In the interim, all of the following standards apply:

(a) For surface waters of the state designated for use for coldwater fish, except for inland lakes as prescribed in R 323.1065, the dissolved oxygen shall not be lowered below a minimum of 6 milligrams per liter at the design flow during the warm weather season in accordance with R 323.1090(2) and (3). At the design flows during other seasonal periods, as provided in R 323.1090(3), a minimum of 7 milligrams per liter shall be maintained. At flows greater than the design flows, dissolved oxygen shall be higher than the respective minimum values specified in this subdivision.

(b) For surface waters of the state designated for use for warmwater fish and other aquatic life, except for inland lakes as prescribed in R 323.1065, the dissolved oxygen shall not be lowered below a minimum of 4 milligrams per liter, or below 5 milligrams per liter as a

daily average, at the design flow during the warm weather season in accordance with R 323.1090(3) and (4). At the design flows during other seasonal periods as provided in R 323.1090(3), a minimum of 5 milligrams per liter shall be maintained. At flows greater than the design flows, dissolved oxygen shall be higher than the respective minimum values specified in this subdivision.

(c) For surface waters of the state designated for use for warmwater fish and other aquatic life, but also designated as principal migratory routes for anadromous salmonids, except for inland lakes as prescribed in R 323.1065, the dissolved oxygen shall not be lowered below 5 milligrams per liter as a minimum during periods of migration.

(3) The department may cause a comprehensive plan to be prepared to upgrade waters to the standards specified in subrule (1) of this rule taking into consideration all factors affecting dissolved oxygen in these waters and the cost effectiveness of control measures to upgrade these waters and, after notice and hearing, approve the plan. After notice and hearing, the department may amend a comprehensive plan for cause. In undertaking the comprehensive planning effort the department shall provide for and encourage participation by interested and impacted persons in the affected area. Persons directly or indirectly discharging substances which contribute towards these waters not meeting the standards specified in subrule (1) of this rule may be required after notice and order to provide necessary information to assist in the development or amendment of the comprehensive plan. Upon notice and order, permit, or other action of the department, persons directly or indirectly discharging substances which contribute toward these waters not meeting the standards specified in subrule (1) of this rule shall take the necessary actions consistent with the approved comprehensive plan to control these discharges to upgrade these waters to the standards specified in subrule (1) of this rule.

R 323.1065 Dissolved oxygen; inland lakes.

Rule 65. (1) The following standards for dissolved oxygen shall apply to the lakes designated for coldwater fish in R 323.1100(4) and (6):

(a) In stratified coldwater lakes which have dissolved oxygen concentrations less than 7 milligrams per liter in the upper half of the hypolimnion, a minimum of 7 milligrams per liter dissolved oxygen shall be maintained throughout the epilimnion and upper 1/3 of the thermocline during stratification. Lakes capable of sustaining oxygen throughout the hypolimnion shall maintain oxygen throughout the hypolimnion. At all other times, dissolved oxygen concentrations greater than 7 milligrams per liter shall be maintained.

(b) Except for lakes described in subdivision (c) of this subrule, in stratified coldwater lakes which have dissolved oxygen concentrations greater than 7 milligrams per liter in the upper half of the hypolimnion, a minimum of 7 milligrams per liter of dissolved oxygen shall be maintained in the epilimnion, thermocline, and upper half of the hypolimnion. Lakes capable of sustaining oxygen throughout the hypolimnion shall maintain oxygen throughout the hypolimnion. At all other times, dissolved oxygen concentrations greater than 7 milligrams per liter shall be maintained.

(c) In stratified coldwater lakes which have dissolved oxygen concentrations greater than 7 milligrams per liter throughout the hypolimnion, a minimum of 7 milligrams per liter shall be maintained throughout the lake.

(d) In unstratified coldwater lakes, a minimum of 7 milligrams per liter of dissolved oxygen shall be maintained throughout the lake.

(2) For all other inland lakes not specified in subrule (1) of this rule, during stratification, a

minimum dissolved oxygen concentration of 5 milligrams per liter shall be maintained throughout the epilimnion. At all other times, dissolved oxygen concentrations greater than 5 milligrams per liter shall be maintained. (Quality & Bureau, January 13, 2006)

The Michigan Department of Natural Resources and the Environment (MDNRE) Part 31 of the Natural Resources and Environmental Protection Act, 1994 PA 451 (as amended) Administrative Rules Part 4 Water Quality Standards in totality is available as Appendix 3.

Temperature thresholds will be based on each water system's fish diversity and the LTBB draft designation as a coldwater, warm water, or warm water fishery with migratory routes for salmonids. References for temperature thresholds in lakes for warmwater and coldwater species are available as Appendix 4.

Limnology (Wetzel 2001, third edition) nutrient thresholds are used in place of numeric exceedence criteria for LTBB waterbodies in this report. Wetzel states that total nitrogen (TN) can range from 0 to 5 milligrams per liter in unpolluted surface waters (Wetzel, 2001). Total phosphorus (TP) concentrations of most uncontaminated surface water are between 10 to 50 micrograms per liter (Wetzel, 2001). The narrative summaries, if these conditions are met, will state that TP and TN are within the ranges found in unpolluted waters. If the water body's nutrient levels exceed these ranges consistently, attainment may need further evaluation or the waterbody may not fully support the LTBB draft uses. Recommendations of an increase in monitoring, a breakdown of those specific exceeding parameters components, and/or parameters that react chemically with these nutrients will be monitored in addition to the current parameters if use attainment is not fully supported or further evaluation is needed in future monitoring designs. These actions will enable better understanding of whether or not these exceedences are being caused by a controllable pollution factor or a natural phenomenon.

In a long-term study of lakes of Wisconsin, lakes of low color and low turbidity levels that have a chlorophyll *a* concentration less than 10 µg/L were more aesthetically pleasing, thus increasing recreational use (Lillie & Mason, 1983). In LTBB waterbodies that share common characteristics of Wisconsin lakes and have a designated use of primary contact recreational or depend highly on recreational activities, the Wisconsin numeric threshold unit will be applied. If the LTBB lake is primarily used as a warm water fishery and/or indigenous aquatic life and wildlife, the indication of algal blooms and/or chlorophyll *a* trends and averages over time will be used to interpret whether or not chlorophyll *a* results are in exceedence.

LTBB will base the degree of support of total suspended solids (TSS) on the effect the results have on fish spawning conditions in each lotic system. LTBB WQS will base the degree of support on recommendations referenced in a study done by D.S. Lloyd based in Alaska. Although Michigan's lotic systems differ in morphology, LTBB waters rarely see TSS levels higher than 20 mg/L. Therefore, recommendations for a "high" level of protection (0-25 mg/l), about 7 NTUs, will be used as threshold in use of support determination (Lloyd, D. S, 1987). If salmonids do not spawn in the system being assessed, this numeric value will still be considered.

Currently, the State of Michigan does not have conductivity standards. Therefore, an overall range of conductivity results will be determined for LTBB baseline waterbodies. Each site's conductivity will be analyzed to determine a range. If there are outliers or there is a large range that does not appear to be consistent with waterbodies with similar physical characteristics, it will be noted and will be analyzed further in future monitoring designs.

Since this Water Quality Assessment Report is the conclusion of the baseline assessment the section within each water body assessment titled "Parameter Results & Baseline Analysis" will not only go over use attainment but baseline analysis as well. Analysis is parameter-specific

and will consist of natural season fluctuation that occurs per parameter, as well as chemical reactions when paired with other parameters, distinct morphology or characteristics of each system, drainage or seepage areas, input and output sources, and any other waterbody specific factors that pertain. Therefore, conclusions can be made, but all components of that particular water system and watershed are considered with the results of trend analysis. If no significant trends are indicated by using yearly averages, they will not be reported. A trend will be considered if approximately seventy percent ($R^2=.7$ or higher) of the variation in the response variable can be explained by the explanatory variable using a simple linear regression. Minimum and maximum baseline values will be determined for each parameter as well as the baseline mean and median when applicable. These types of calculations and analysis will be used to determine the direction in which the Tribe wants to utilize this data in terms of water quality protection legislation. Recommendations on the pursuance of water quality standards, Tribal uses, and/or other types of water quality legislation will be based on the analysis conducted in this report.

Habitat assessments are calculated and result in a numerical score. Habitat assessments are compared to previous year's habitat assessments for changes in scores for each habitat condition and overall score. Lake habitat assessments currently being utilized began in 2006, so there will only be a 2 year comparison done. Note that the habitat assessments are qualitative and solely based on the observer. Therefore, human bias is a factor in these assessments. The lake habitat assessment forms include a habitat condition ranking for invasive aquatic vegetation. This score will be calculated with only invasive aquatic vegetation that has been identified by 106 Water Staff, other 106 staff, or other water resources organizations such as Tip of the Mitt Watershed Council. These invasive aquatic vegetation types include; *Myriophyllum spicatum* (Eurasian watermilfoil), *Potamogeton crispus* (curly-leaf pondweed), nuisance species *Cladophora*; a genus of reticulated filamentous Ulvophyceae, the invasive *Phragmites australis*, and *Lythrum salicaria* (purple loosestrife). If other invasives or nuisance species have been identified they will be included in the scoring process. These invasives include but are not limited to: *Dreissena polymorpha* and *Dreissena rostriformis bugensis* (zebra and quagga mussels), *Neogobius melanostomus* (round goby), and *Orconectes rusticus* (rusty crayfish). All invasive species considered in the scoring process are identified on the habitat assessment forms.

Results for the 2007 aquatic macroinvertebrate field collection are reported by using the Shannon-Weiner Diversity Index and specific metrics. The metrics calculated are available and their response to increasing perturbation is available below. These results are available in narrative summaries at sites where macroinvertebrates were collected in 2007. Analysis will include data through 2007.

STREAMS	Category	Metric	Definition	Response to increasing perturbation
	Composition	% EPT	Percent of the composite of Ephemeroptera, and Trichoptera larvae	Decrease
	Composition	% Chironomidae	Percent of midge	Increase

			larvae	
	Tolerance / Intolerance	% Hydropsychidae to Trichoptera	Relative abundance of pollution tolerant caddisflies	Increase
	Diversity	Shannon - Weiner Diversity Index	Combine taxa richness and abundance in a summary statistic	Decrease
	Category	Metric	Definition	Response to increasing perturbation
LAKE S	Compostition	% EPO	Percent of the composite of Ephemeroptera, Plecoptera, and Odonata larvae	Decrease
	Compostition	% Oligochaetes	Percent of oligochaete worms	Increase
	Tolerance / Intolerance	% Dominant Taxon	Measures the dominance of the single most abundant taxon	Increase
	Diverstiy	Shannon - Weiner Diversity Index	Combine taxa richness and abundance in a summary statistic	Decrease

Lake Narrative Summaries
(See Appendix 2 for all uses and support attainment)

1. O’Neal Lake

A. Description and Background

O’Neal Lake is a small shallow lake located in Northern Emmet County. It is hydrologically connected and receives some drainage from Lawrence Lake and has one outlet, the headwaters of Big Sucker Creek. O’Neal Lake is approximately 145 acres in surface area. O’Neal Lake is part of the Lake Michigan watershed. The land cover surrounding O’Neal Lake is predominantly forested wetland and some upland. The area surrounding O’Neal Lake is owned by the Michigan Department of Natural Resources and the Environment (MDNRE), the State of Michigan, and a 14.3 acre parcel owned by a private individual. A dam built in 1952 is still present on O’Neal Lake along with many inundated dead trees. LTBB monitors at one monitoring site collecting data at an approximate mid-depth of 0.5 meters.

B. Tribal Use and Lake Management

The condition and current management of this dam has influenced interest in the future management of O’Neal Lake by the MDNRE, local citizens, LTBB and LTBB NRD staff, and other wildlife/environmental organizations. The dam has been in need of repair for many years, causing local citizens to contact the MDNRE to issue the need for a repair. MDNRE’s response was to replace the boards and leave 10 inches out of the 60 inches of the boards in allowing for a partial drainage of the lake to approximately 50 acres with a depth of 2-8 inches (“Save O’Neal Lake”). The drawdown would allow for an increase in waterfowl habitat, by exposing the accumulated organic material to the air allowing decomposition so nutrients can be utilized by plants for growth. The assumption is that the nutrients in the plants will then be available to a wide variety of wildlife species. (Brian Mastenbrook, 2007)

O’Neal Lake has designated the Tribal primary use as a warm water fishery. Other designated uses are indigenous aquatic life and wildlife, wild rice area, cultural/ceremonial, and partial secondary/contact recreational. LTBB Natural Resources Inland Fisheries and Wildlife staff have conducted wildlife and fish surveys on O’Neal Lake resulting in the conclusion that O’Neal Lake is a viable warm water fishery and provides a diverse wildlife habitat at its current depth and size. Fish surveyed were of ample size and diversity. See Figure 3 for diversity and size data presented by the LTBB NRD Inland Fisheries and Wildlife staff.

Species	Individuals Caught	Mean Length (inches)	Length Range (inches)	Catch Per Unit Effort (net night)
Blue Gill	1113	7.5	2.3-9.8	30.9/night
Northern Pike	80	17	11.5-29.8	2.2/night

Largemouth Bass	99	14	9.0-19.7	2.75/night
Pumpkinseed	128	6.8	2.6-8.7	3.6/night
Rock Bass	28	6.9	5.4-8.8	0.8/night
Yellow Perch	23	8	6.9-8.9	0.6/night
Smallmouth Bass	2	17.2	13.9-20.5	<0.1/night

Figure 3: Number of species caught, mean length (inches), length range (inches) and catch per unit effort (based on 36 net nights) of blue gill, northern pike, largemouth bass, pumpkinseed, rock bass, yellow perch and smallmouth bass sampled during fyke netting on Lake O'Neal, Emmet County Michigan, May 2008.

Wildlife data includes the observation of an osprey and its nest, large population of painted turtles, a few snapping turtles, bald eagles, and an assortment of waterfowl inhabiting the O'Neal Lake Watershed. See Figure 4 for Waterfowl Percentages observed 2002-2009.

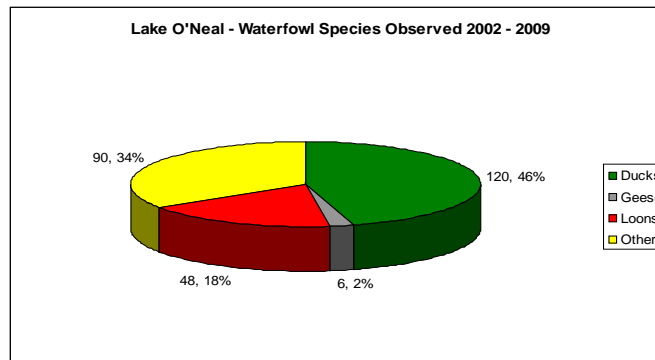


Figure 4: Waterfowl Percentage between 2002-09

The LTBB NRD and Environmental staff presented water quality, wetlands, fisheries, and wildlife data at a public information meeting held at the Bliss Township Hall on August 27th, 2009. Since then, the LTBB Natural Resource Commission passed opposition to the drawdown of O'Neal Lake. LTBB has communicated to the Michigan Department of Natural Resources and the Environment (MDNRE) to be consulted with for the O'Neal Lake Management Plan the MDNRE is creating for O'Neal Lake.

C. 2010 Tribal Use Attainment

In 2010, all parameters were within criteria to fully support a warm water fishery and all other designated uses except wild rice area use. The spawning threshold for Bluegill available in Appendix 4 was used for attainment considerations and for baseline analysis. Although, there are

exceedences in 2010 summer data, they are minor and the threshold criteria used is based on weekly averages at unknown intervals. The wild rice area designation will need further evaluation. Wild rice has been planted every fall in O'Neal Lake for the past four years by NRD Wildlife and Fisheries staff. Whether or not the growth has been successful for wildlife or subsistence needs to be established by the Tribe and discussed internally by NRD staff. The LTBB WQS will work with other NRD staff to address any needs or further monitoring that the 106 Surface Water Quality Monitoring Program could offer to further this endeavor and to fully support this use.

D. Parameter Results & Baseline Analysis

1. Dissolved Oxygen

Table 1. Dissolved Oxygen (DO)

2000-2010 (Even Years Only)	Results in Mg/L	Date
Minimum	2.0	2/19/2008
Maximum	11.5	2/8/2010
Mean	9.1	
Median	9.4	

The 2008 minimum result indicates there may have been a winter fish kill during this year. Winterkills are assumed to be likely when daytime average dissolved oxygen is below 4 mg/L (Barica, 1979). Ice cover in 2008 was already 14 to 15 inches thick with steady cold weather and winter precipitation during this period. In 2010, the maximum DO reading may have been a result of a winter algal bloom that may have occurred due to sunny days and less ice cover. Winter algal blooms are being indicated by DO results at other water bodies with similar characteristics as well. There were no significant DO trends from year to year at O'Neal Lake.

2. Temperature

Table 2. Temperature °C

2000-2010 (Even Years Only)	Results in °C	Date
Minimum	1.4	2/19/2008
Maximum	27.2	8/11/2010
Mean	17.5	
Median	19.1	

The maximum temperature taken in August took place at 11:30 AM during the time when summer temperatures are at their highest. Figure 5 illustrates the field season averages compared to the Bluegill spawning threshold used in this assessment. Optimal temperatures for Bluegill spawning are below 25°C. Temperature readings taken in the winter were excluded from this analysis.

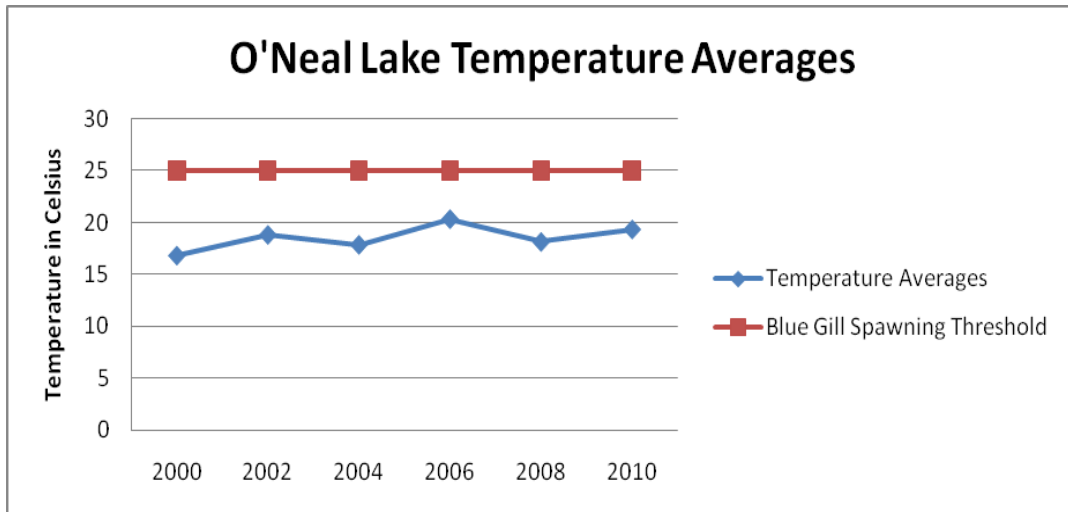


Figure 5: O'Neal Lake Temperature Averages

3. Conductivity

Table 3. Conductivity $\mu\text{S}/\text{cm}$

2000-2010 (Even Years Only)	Results in $\mu\text{g}/\text{L}$	Date
Minimum	233.6	5/17/2002
Maximum	376.4	2/8/2010
Mean	291.2	
Median	292.9	

Since, there is not a conductivity standard used for analysis or use attainment, the data is consistent in range of other water bodies with similar characteristics. The highest conductivity results are in the winter. The lake is in a remote area; therefore runoff is not an issue.

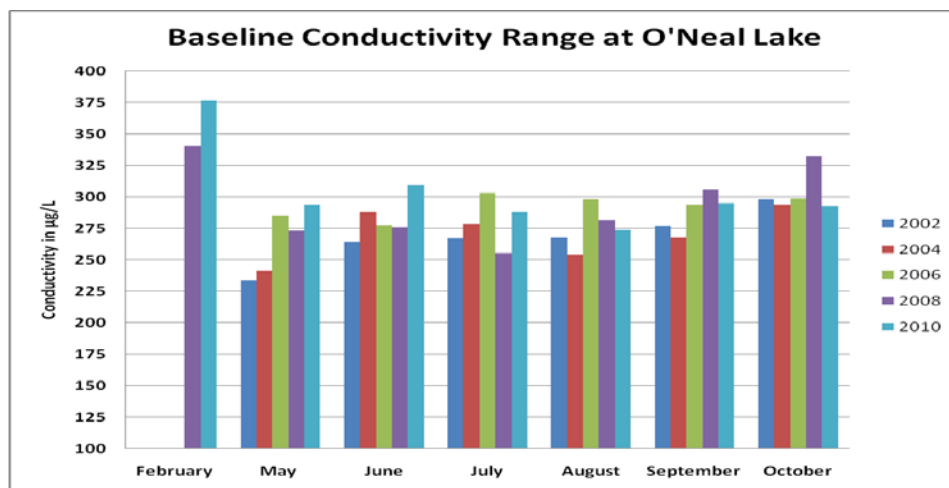


Figure 6: Baseline Conductivity Range at O’Neal Lake

4. Chloride

Table 4. Chloride mg/L

2000-2010 (Even Years Only)	Results in mg/L	Date
Minimum	1.4	7/23/2004 & 10/11/2004
Maximum	4.7	2/8/2010
Mean	3	
Median	3	

The minimum results for chloride are from July and October of 2004 and the maximum is from the winter sampling event in 2010. These results and range are very low in terms of chloride levels and are within attainment of Michigan Water Quality Standards.

5. pH

Table 5. pH units

2000-2010 (Even Years Only)	pH Results	Date
Minimum	7.1	6/6/2006
Maximum	8.9	5/15/2004
Mean	8.8	
Median	8.3	

These baseline pH levels are within the acceptable range of 6.5-9 stated in the Michigan Water Quality Standards. The results of a higher pH are representative of hard water marl lakes.

6. Total Phosphorus

Table 6. Phosphorus in µg/L

2000-2010 (Even Years Only)	Results in µg/L	Date
Minimum	0.95	6/4/2010
Maximum	17.8	7/20/2000
Mean	7.7	
Median	8.0	

These baseline results are all within the 10-50 µg/L range found in unpolluted waters. Assuming that O’Neal Lake is a marl hard water lake with a high composition of calcium carbonate, phosphorus may be bound in the substrate lowering the possibility of algal blooms and minimizing phosphorus content within the water column. LTBB is conducting a substrate study in 2011 on O’Neal Lake to identify calcium carbonate percentage. The abundance of aquatic vegetation also indicates that the aquatic plants are utilizing phosphorus components within the substrate for growth.

7. Total Nitrogen

Table 7. Total Nitrogen in mg/L

2000-2010 (Even Years Only)	Results in mg/L	Date
Minimum	0.14	10/11/2004

Maximum	1.1	7/22/2008
Mean	0.6	
Median	0.6	

These baseline results are within the 0-5 mg/L range found in unpolluted waters.

8. Chlorophyll *a*

Table 8. Chlorophyll *a* in µg/L

2000-2010 (Even Years Only)	Results in µg/L	Date
Minimum	0.4	9/3/2002
Maximum	5.6	10/10/2002
Mean	1.6	
Median	1.0	

Chlorophyll *a* levels are less than 10 µg/L indicating a lake preferable for recreational uses with minimal chance of algal blooms.

9. *E. Coli* Bacteria

E. coli bacteria samples are not taken at O'Neal Lake by the Northwest Michigan Community Health Agency (NMCHA). These sites are not identified by LTBB as sites of priority for future *E. coli* bacteria testing. Although, a host of waterfowl use this lake as habitat, the conditions for swimming are highly unfavorable due to the vegetation, woody debris, and primarily soft bottom.

10. Habitat Assessment

The score for the habitat assessment completed in 2008 was 114 and the score for 2010 was 109. The total possible score for a habitat assessment is 160. The minor decrease in score from 2008 and 2010 is contributed to a lower lake water level. A natural breach, the start of another natural breach, and a broken board accounted for this decrease in water levels. Culverts/culvert condition (includes dams and breaches) and hydrological alteration also contributed to the breaches and the dam condition.

11. Macroinvertebrates

2008 macroinvertebrates have not been completed, therefore an assessment is unavailable. 2008 and 2010 data will be analyzed to indicate whether or not the increasing trends of Ephemeroptera, Plecoptera, and Trichoptera orders have continued. See Figure 7 below for past trends.

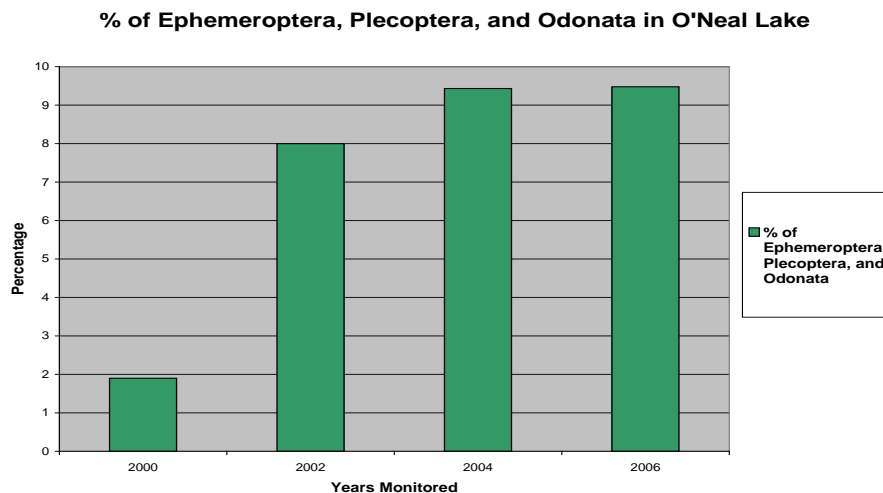


Figure 7: Percentage of EPO in O’Neal Lake

E. Conclusion and/or Recommendations

In conclusion of the baseline study results, O’Neal Lake is not a lake that is considered to have much potential for impairment of the Tribal uses assigned. The primary concern of this lake is how it is to be managed. The lake is within a culturally significant geographical area to the Tribe. Therefore, the Tribe classifies this lake as a high priority for natural resource monitoring. The Tribe will also continue its research and efforts to evaluate whether or not wild rice can be sustained on this lake. The water quality data depicts low levels of nutrients within its water column. However, optimum populations of aquatic vegetation primarily, *Myriophyllum heterophyllum*, indicate that nutrients are bound in the soil.

Due to O’Neal lake’s cultural significance and priority to the Tribe, monitoring will continue seasonally every two years with a winter sampling event each year. Winter sampling is important to detect winter fish kills, ice cover, winter algal blooms, and to see if the trend of conductivity and chloride continues in the winter months. The Tribe will continue its effort to be included in the creation of a management plan with the MDNRE that will be based on Tribal and State data.

2. Round Lake

A. Description and Background

Round Lake is a small, shallow spring-fed lake with an inlet creek connected to the north arm of Spring Lake and an outlet creek connecting to Crooked Lake. Round Lake is part of the Lake Huron Watershed. Historically, Odawa people frequently portaged their canoes over the sand dunes between Lake Michigan and Round Lake, and then followed river courses connecting Crooked, Burt, and Mullett Lakes to Lake Huron. Round Lake’s present land coverage consists of seasonal and residential homes, condominiums, two nature preserves (Fotchman and Round Lake), a small beach, a public launch and access site.

Round Lake has a surface area 353.4 acres and one monitoring site where data is collected at 2.1 meters mid-depth of the water column.

B. Tribal Use and Lake Management

LTBB has designated the primary use of Round Lake as primary contact recreational. Other designated uses include indigenous aquatic life and wildlife and warm water fishery. Round Lake has been stocked by the MDNRE in the past with walleye. The last stocking was in May of 1998 according to the MDNRE fish stocking website (Resources, 2001-2005). Stocking has not continued by the MDNRE because the department believes natural reproduction productivity is absent or minimal for walleye. Warm water fish in Round Lake consist of but are not limited to Bluegill, sand shiners, rock bass, northern pike and largemouth bass, according to LTBB NRD fish surveys conducted in summer and fall of 2009. LTBB fish surveys conclude that Round Lake is a viable warm water fishery with natural reproduction of warm water fish species (Haynes, 2011). According to LTBB wildlife staff, loon activity is present on Round Lake and has been since the 1990's (Field). An area of Round Lake is marked with buoys to minimize disturbance of the loon's nesting area. A bald eagle has also been observed at Round Lake, and terns also frequent the lake diving for fish.

C. 2010 Tribal Use Attainment

In 2010, attainment classification of indigenous aquatic life and wildlife and warm water fishery were fully supported. When using Bluegill spawning as reference criteria there was one exceedence in August of 2010. However, this data was taken at the hottest part of the summer during the day time hours. The average field season temperature was below the spawning threshold. Due to *E. coli* bacteria not being tested by the NMCHA on Round Lake, the primary use of primary contact recreational is assessed as needing further evaluation.

D. Parameter Results & Baseline Analysis

1. Dissolved Oxygen (DO)

Table 1. Dissolved Oxygen in mg/L

2000-2010 (Even Years Only)	Results in mg/L	Date
Minimum	1.09	2/5/2008
Maximum	12.5	5/2/2006
Mean	8.8	
Median	8.8	

The minimum DO result taken during the winter sampling event in 2008 was taken at 2.4 instead of 2.1 meters to consider ice thickness. Ice coverage is taken into consideration when determining mid-depth measurements in the winter. Any measurements taken below mid-depth in the winter during 2008 and 2010 have resulted in low DO results. Depletion of oxygen during the winter may be contributed to respiratory utilization and chemical oxidations that increase with depth. DO measurements nearing the surface are within criteria to support a warm water fishery as depicted in Figure 8.

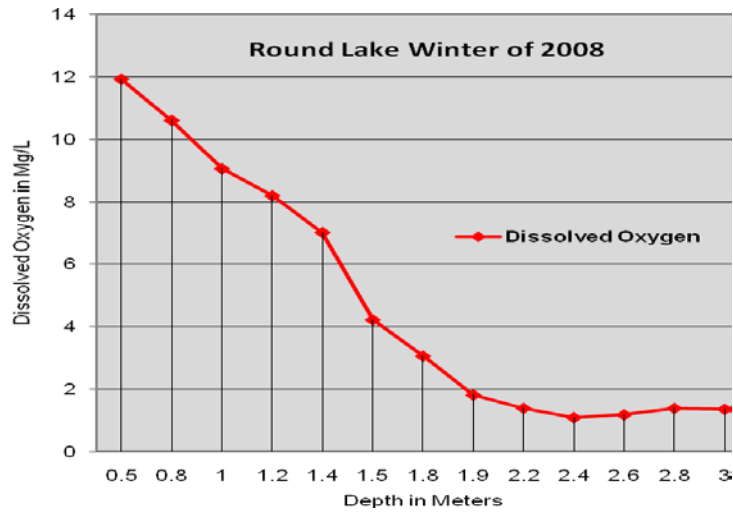


Figure 8: Dissolved Oxygen Concentration at Specific Depths

There was a trend ($R^2=0.7$) of dissolved oxygen concentrations increasing over the progression of time of the baseline study. See Figure 9.

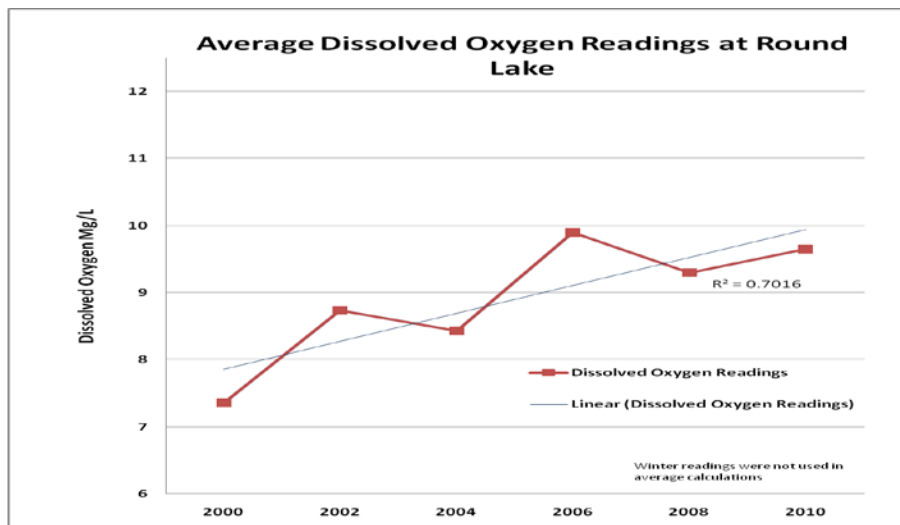


Figure 9: Dissolved Oxygen Concentration Trend

2. Temperature

Table 2. Temperature in °C

2000-2010 (Even Years Only)	Results in °C	Date
Minimum	4.1	5/2/2006
Maximum	25.6	8/4/2010
Mean	18.6	

Median	20.2	
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The spawning threshold for Bluegill was utilized for analysis of baseline temperature data taken at Round Lake. See Figure 10 illustrating yearly average temperatures being below the optimum Bluegill spawning threshold.

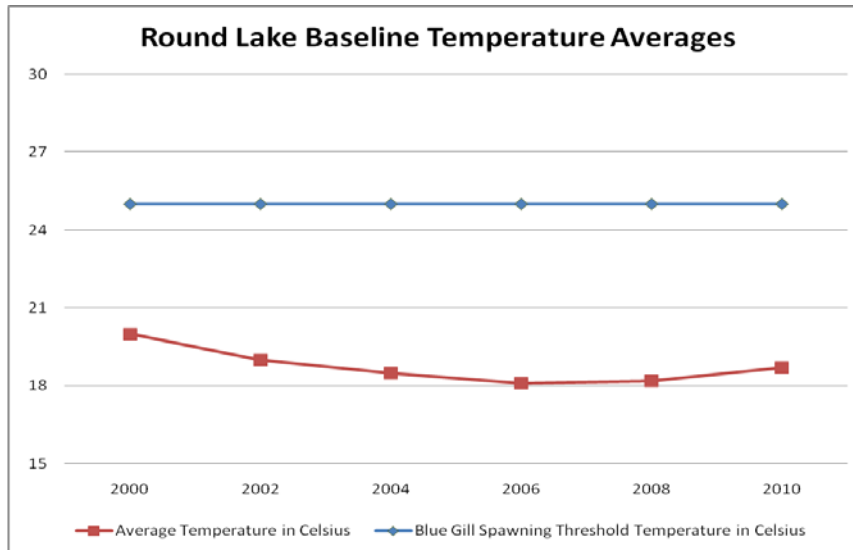


Figure 10: Round Lake Baseline Temperature Averages

Although the R^2 value was not 0.7 or over, the trendline was $R^2=0.5$ indicating that the decreasing temperature is 50% dependent on the progression of time. Winter temperature results were not used in the average temperature calculations. Optimal temperatures for Bluegill spawning are below 25°C , so the temperatures at Round Lake were optimal.

3. Conductivity

Table 3. Conductivity $\mu\text{g/L}$

2000-2010 (Even Years Only)	Results in $\mu\text{g/L}$	Date
Minimum	246.8	8/4/2008
Maximum	394.2	2/5/2008
Mean	301.8	
Median	301.5	

The maximum conductivity reading may be contributed to winter groundwater flux and increased use of road salt. There was a significant trend of increasing conductivity ($R^2=0.89$) dependent on increasing time period of the baseline study. Figure 11 depicts the increase as well as the monthly ranges over the course of the baseline study.

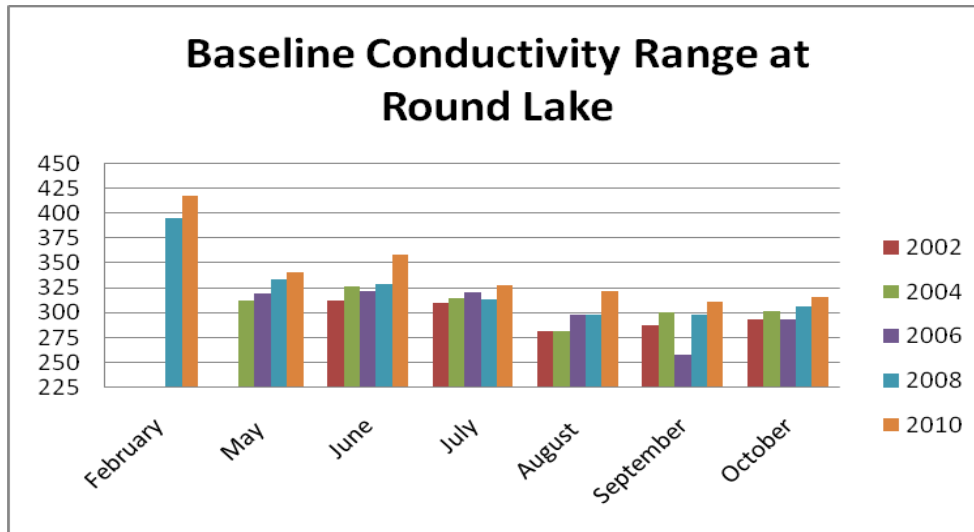


Figure 11: Baseline Conductivity Range at Round Lake

4. Chloride

Table 4. Chloride mg/L

2000-2010 (Even Years Only)	Results in mg/L	Date
Minimum	19.5	7/12/2002
Maximum	35.8	2/18/2010
Mean	25.6	
Median	25.7	

The chloride result for the 2008 winter sampling event was also comparable to the maximum result taken in 2010, possibly related to runoff of road salt.

Chloride averages have increased just as conductivity has over the progression of the baseline study. See Figure 12.

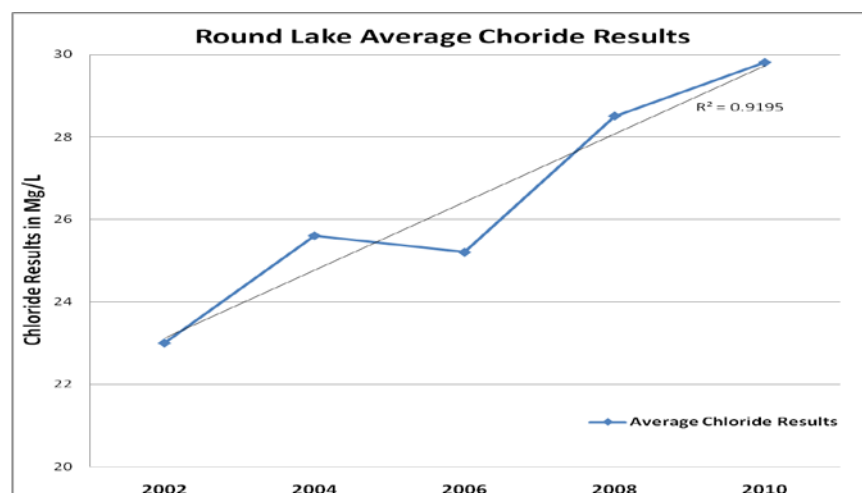


Figure 12: Round Lake Average Chloride Results

Statistical analysis using the Pearson Product Moment Correlation was completed using conductivity and chloride baseline results resulting in a P value supporting a correlation that when one of these variables increase so does the other.

5. pH

Table 5. pH units

2000-2010 (Even Years Only)	pH Results	Date
Minimum	7.1	7/11/2000
Maximum	9	7/8/2002
Mean	8.4	
Median	8.5	

The results over the time period of the baseline study are within the acceptable 6.5-9 range.

6. Phosphorus

Table 6. Phosphorus in µg/L

2000-2010 (Even Years Only)	Results in µg/L	Date
Minimum	1.6	8/4/2000
Maximum	16.7	7/11/2000
Mean	7.2	
Median	7.6	

These baseline results are within the 10-50 µg/L range that would be found in unpolluted waters.

7. Total Nitrogen

Table 8. Total Nitrogen in mg/L

2000-2010 (Even Years Only)	Results in mg/L	Date
Minimum	0.19	5/2/2006
Maximum	2.8	9/23/2002
Mean	0.68	
Median	0.68	

The baseline results are within the range of 0-5 mg/L found in unpolluted waters.

8. Chlorophyll *a*

9. Table 8. Chlorophyll *a* in µg/L

2000-2010 (Even Years Only)	Results in µg/L	Date
Minimum	0.1	8/14/2006
Maximum	6.8	10/4/2004
Mean	1.8	
Median	1.5	

Chlorophyll *a* averages less than 10 µg/L creating an aesthetically pleasing lake for recreational users. There is a dense population of aquatic vegetation in Round Lake, supporting fish habitat as well as the majority of nutrients supply being contained in the sediment. The color

of Round Lake does become greenish and turbid during the late summer months; this may be a result of the decomposition of aquatic plants, productivity, or algal blooms.

9. *E. coli* Bacteria

NMCHA does not currently test for *E. coli* bacteria at Round Lake. This lake is one of the lakes that the LTBB lab and water staff identified as a site that should be monitored due to the primary use classification being primary contact recreational. The LTBB WQS and a representative of NMCHA *E. coli* Lake Monitoring Program discussed the need for inclusion of Round Lake in future monitoring designs. However, follow up on this inclusion has not been conducted at this time.

10. Habitat Assessment

The score for the habitat assessment completed in 2008 was 135 and the score for 2010 was 124. This is an estimated 5% change from 2008 to 2010. When analyzing each parameter the distribution of the change was only considerable in one habitat parameter--Culverts/Culvert Condition. The 2008 habitat assessment must not have included the culvert at the inlet creek connecting Round Lake and Spring Lake in the assessment whereas the 2010 assessment included this culvert. There are not other control structures or culverts on this lake that the WQS is aware of.

11. Macroinvertebrates

2008 macroinvertebrates have not been completed, therefore an assessment is unavailable. Past data indicated the increase of chironomids and the absence of pollution sensitive families. When the 2008 survey is completed, the WQS will confirm whether or not these results are becoming a trend.

E. Conclusion and/or Recommendations

In conclusion to the baseline results, the LTBB WQS will follow up with NMCHA to pursue *E. coli* bacteria testing or receive a clear explanation of why it is not currently tested and why it should not be tested in the future. It may be due to the existing waterfowl activity on this lake, which could cause positive *E. coli*. However, not all strains of *E. coli* are detrimental to human health and some may be more detrimental than others. Positive results could cause prohibition of recreational and swimming activities when unnecessary. If testing does not occur and waterfowl activity take precedent over primary contact, the WQS may seek to change the primary use from primary contact recreational to either a warm water fishery or indigenous aquatic life and wildlife. Primary contact recreational would still be a designated use. The WQS would like to pursue an Aquatic Vegetation Study on this lake as well, to better understand the productivity and physical characteristics in this waterbody. LTBB WQS will meet annually with Wildlife NRD staff to discuss and utilize any other wildlife data collected in the future or previously that was not mentioned in this baseline assessment.

3. Susan Lake

A. Description and Background

Susan Lake is a small, shallow lake with a surface area of 119 acres located in Charlevoix County. Susan Lake is part of the Little Traverse Bay Watershed. Mud Creek, which flows out of

Mud Lake, drains into Susan Lake. Susan Lake drains into Susan Creek, which meanders through LTBB's property at Taimi Lynne Hoag Natural Area, and discharges into Little Traverse Bay. The land cover around Susan Lake consists of an estimated 65% residential and seasonal/residential housing, 5% public boat launch and public access, and 30% forested and scrub/shrub wetland area.

Susan Lake is within a geographical area of cultural significance. This geographical area is called Kitchiossening in Anishnaabemowin, which translates in English to Big Stone. There is a church, Greensky Hill, just to the west of and overlooking Susan Lake. The Greensky Hill Church was founded by Chippewa Indian missionary Peter Greensky in the 1840's. The lake was used by Tribal bands prior to the founding of the church. The lake was named after Peter Greensky's wife, Susan Walker Greensky. The church is still active with Tribal participation. An ancient burial ground surrounds the church down to the shores of Susan Lake to Boyne City/Charlevoix road. Odawa and other Tribes would meet to discuss Tribal issues and collaborate on decisions around a stand of trees adjacent to the church. Routes of migration for the Odawa bands are adjacent to Susan Lake as well. During the annual migrations south and returns to the north, those who wished to winter here subsisted on ice fishing and inland hunting in Susan Lake and Lake Charlevoix. Susan Lake was used in the past by Tribal citizens for its freshwater clam resource. Tribal citizens would gather the clams in a bucket and supply the clams with corn meal. The clams would eat the corn meal and excrete the corn meal and toxins that could be harmful if eaten (Walker, 2011).

Susan Lake has one monitoring site where data is collected at a mid-depth of 1.5 meters.

B. Tribal Use and Management

The LTBB draft primary use is as a warm water fishery. The LTBB draft designated uses are indigenous aquatic life and wildlife, primary contact recreational, and cultural/ceremonial. Fish commonly caught are yellow perch, Bluegill, largemouth bass, and northern pike. Deer, turtles, a variety of birds, and moderate to heavy amounts of submerged and emergent aquatic vegetation are also common in this lake.

C. 2009 Tribal Use Attainment

In 2009, all parameters were within threshold criteria to support a warm water fishery except the results of dissolved oxygen during the winter sampling event. Since winterkills are assumed to be likely when daytime average dissolved oxygen is below 4 mg/L and the result was 0.23 mg/L the support attainment for a warm water fishery and indigenous aquatic life and wildlife will need further evaluation. This was the first winter sampling event done on this lake. Further evaluation will include continued winter sampling event on this water body to either confirm or deny that winter fish kills are taking place biannually. Cultural/ceremonial uses as well as primary contact recreational use will also need further assessment since *E. coli* testing is not conducted presently on this lake. LTBB Water Quality staff did get Cercarial Dermatitis, also known as Swimmer's Itch, in 2009 at Susan Lake furthering the need for future evaluation for the primary contact recreation use and whether or not this water body supports it.

D. Parameter Results & Baseline Analysis

1. Dissolved Oxygen

Table 1. Dissolved Oxygen in mg/L

2001-2009 (Odd Years Only)	Results in mg/L	Date
Minimum	0.23	2/17/2009
Maximum	11.94	5/1/2007
Mean	9.3	
Median	9.5	

As mentioned in the Tribal Use Attainment section a daily average under 4 mg/L may constitute a winter fish kill concluding that in 2009 a fish kill may have occurred if based solely on one data point. Continued winter monitoring will occur in future years. At all other times of the year and throughout the baseline study dissolved oxygen concentrations have been viable to fish and aquatic life.

2. Temperature

Table 2. Temperature in °C

2001-2009 (Odd Years Only)	Results in °C	Date
Minimum	4.8	2/17/2009
Maximum	27.5	8/2/2007
Mean	18.9	
Median	20.2	

The maximum temperature data point is above the spawning threshold for Bluegill, but was taken during the hottest part of the summer and day. It is the only temperature recorded above 25°C. Temperatures can vary considerably throughout the day and throughout the lake, therefore this reading is not a cause for concern for fish spawning, growth, or embryo survival. Optimal temperatures for Bluegill spawning are below 25°C.

3. Conductivity

Table 3. Conductivity µg/L

2000-2010 (Even Years Only)	Results in µg/L	Date
Minimum	207.5	8/2/2007
Maximum	413	2/17/2009
Mean	261	
Median	256.6	

Figure 13 is a box plot displaying the range of conductivity reading during the duration of the baseline assessment. The box plot displays the 10th, 25th, 75th, and 90th percentile as well as the maximum and minimum results as outliers. The dashed blue line represents the median.

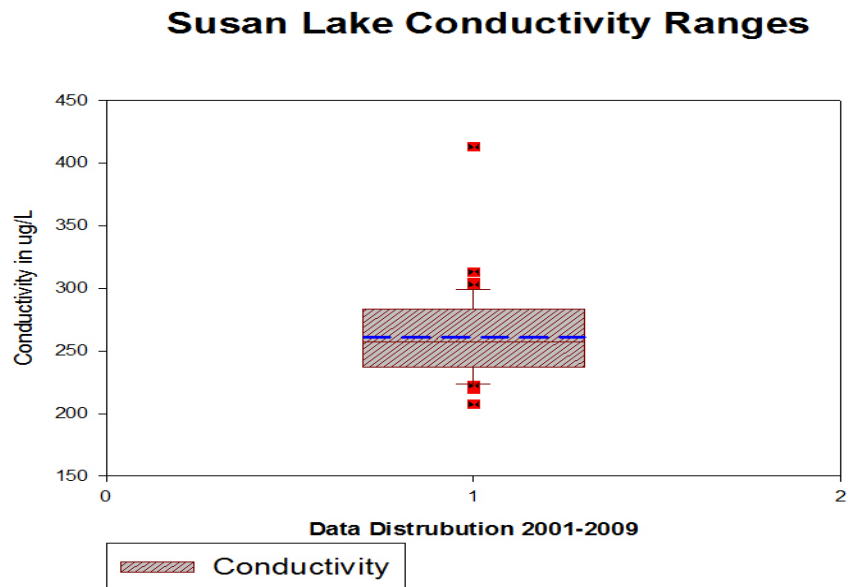


Figure 13: Susan Lake Conductivity Ranges

4. Chloride

Table 4. Chloride mg/L

2001-2009 (Odd Years Only)	Results in mg/L	Date
Minimum	0.63	5/9/2001
Maximum	34	8/29/2001
Mean	9.18	
Median	9.2	

This range is large considering the minimum and maximum results were recorded in the same year. There was a trend $R^2=0.71$ of chloride increasing over time at Susan Lake. However, these baseline results are well within ranges that support all Tribal uses and the concentrations are still considered minimal. Future analysis will be conducted on chloride results to see if this trend continues. See Figure 14.

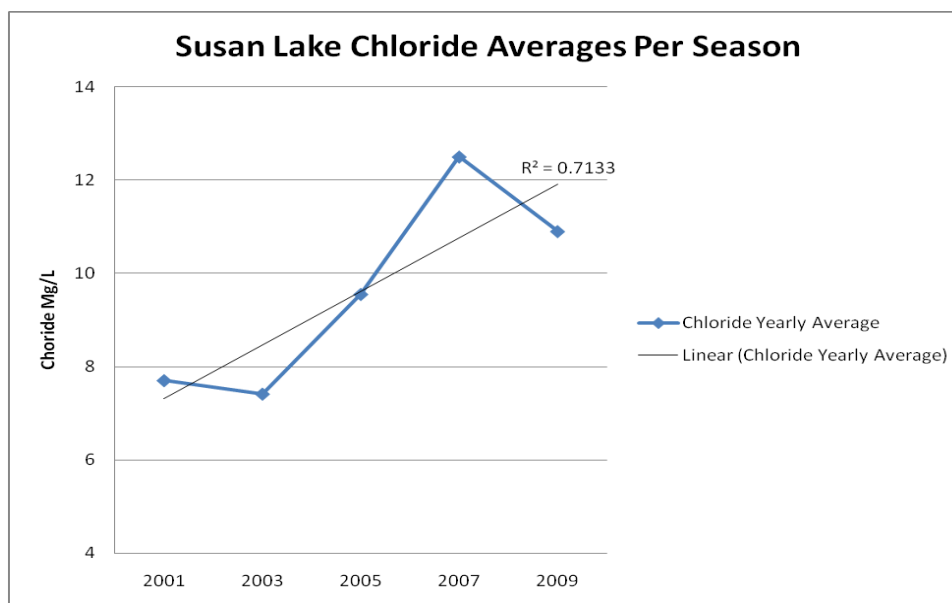


Figure 14: Susan Lake Chloride Averages Per Season

5. pH

Table 5. pH units

2001-2009 (Odd Years Only)	pH Results	Date
Minimum	7.9	6/10/2009
Maximum	8.96	8/2/2007
Mean	8.4	
Median	8.4	

The results are within pH ranges used in this assessment to support Tribal uses.

6. Total Phosphorus

Table 6. Phosphorus in µg/L

2001-2009 (Odd Years Only)	Results in µg/L	Date
Minimum	4.7	10/11/2001
Maximum	27.9	6/5/2007
Mean	10.2	
Median	9.5	

All baseline results are within the threshold values found in unpolluted waters.

7. Total Nitrogen

Table 7. Total Nitrogen in mg/L

2001-2009 (Odd Years Only)	Results in mg/L	Date
Minimum	0.46	5/9/2001
Maximum	5.1	9/9/2003
Mean	1.04	
Median	0.88	

The maximum result of 5.1 was contributed to a high total kjeldahl nitrogen concentration of 5.1 mg/L. This was the only sampling event that had concentrations over 1.2 mg/L. Although, this result exceeded the range of 0-5 mg/L of unpolluted waters, the infrequency of occurrence and absence of trending increase leads to the conclusion that there is no need for further evaluation.

8. Chlorophyll *a*

Table 8. Chlorophyll *a* in µg/L

2001-2009 (Odd Years Only)	Results in µg/L	Date
Minimum	0.32	10/2/2003
Maximum	4.8	6/5/2007
Mean	1.3	
Median	1.1	

Chlorophyll *a* levels are within the range of supporting recreational use and all other designated uses.

9. *E. coli* Bacteria

Susan Lake is not currently tested for *E. coli* by the NMCHA. This is another lake that has been identified by LTBB WQS that has a need to be tested. This was discussed with the NMCHA representative. Follow up will be done by the WQS with NMCHA to get a justification of why it should be tested or see if it could be an additional site to be monitored in the future.

10. Habitat Assessment

The 2007 habitat assessment has a total score of 140. The 2009 habitat assessment was scored at 141. Therefore, significant changes over time were not observed for habitat parameters assessed.

10. Macroinvertebrates

Susan Lake macroinvertebrate baseline survey does not indicate any trends in diversity score, percentage of oligochaetes, or dominant taxon. However, there is a significant trend ($R^2 = .99$) of a decrease in pollution sensitive orders; Ephemeroptera, Plecoptera, and Odonata (EPO). There is also a significant trend ($R^2 = .96$) of an increase in percentage of the order diptera, which for the most part are pollution tolerant. The change in macroinvertebrate diversity appears not to be correlated to nutrient or chemical parameters but may be linked to the depletion of oxygen levels in the winter. See Figure 15 for a chart indicating these trends.

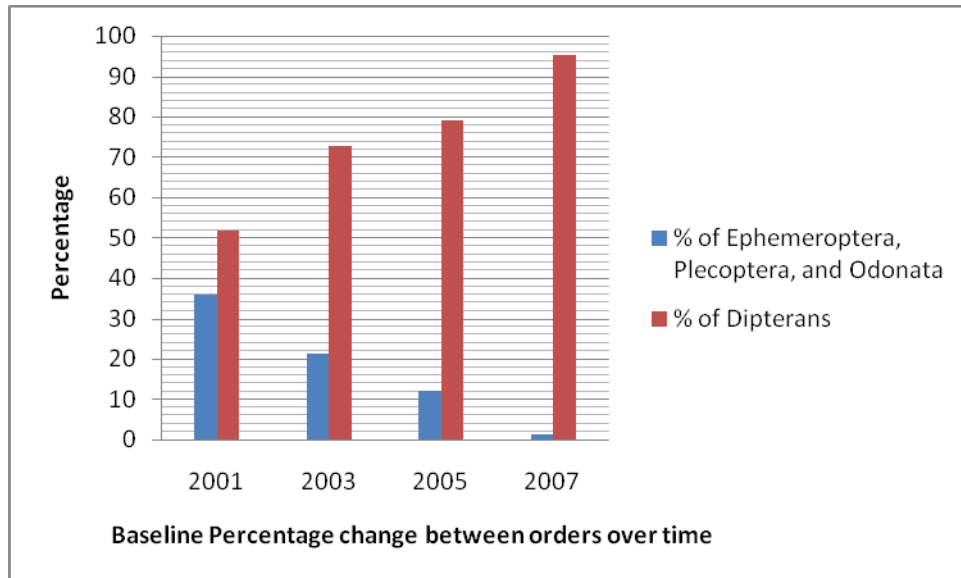


Figure 15: Baseline Percentage change between Macroinvertebrate Orders over time

E. Conclusion and Recommendations

In conclusion to the baseline study results, impairment potential is moderate at Susan Lake. Monitoring every two years will be continued seasonally. The WQS will specifically analyze data to indicate the possibility of winter fish kills based on dissolved oxygen readings, and the trends of decreasing pollution sensitive macroinvertebrate orders continues. Research will be conducted to address the possibility that macroinvertebrates are being affected by the depletion of oxygen if they overwinter. The WQS will also recommend to the NRD Inland Fisheries Biologists that a fish survey should be completed on Susan Lake to further assess the fishery. Follow up will be conducted with NMCHA for the addition of Susan Lake in their *E. coli* Bacteria Monitoring Program or a justification of why it shouldn't be. If *E. coli* is not tested and more reports of Cercarial Dermatitis are reported, swimming may not be recommended and primary contact recreational may be excluded as a Tribal use. All parameters will continue to be analyzed for trends.

4. Larks Lake

A. Description and Background

Larks Lake is a shallow spring fed marl lake with a surface area of 593 acres. The Larks Lake watershed is a small watershed with a land surface area of 4,640 acres. The Larks Lake watershed is a sub watershed of the larger Cheboygan River Watershed. The Cheboygan River Watershed covers 1,461 square miles. Larks Lake drains into Brush Creek which meanders through Pleasantview Swamp. Within the Pleasantview Swamp are four "spring ponds" (called The Four Lakes) that form the headwaters of the Maple River.

Land cover surrounding the lake is seasonal and/or year round residential housing, a county park area with a sandy beach, a public access and boat launch area, with a predominate area of land consisting of forested lowland and wetland. In the 1900's, there was a saw mill operation adjacent to Larks Lake and a dam at the headwaters of Brush Creek. According to the local

community the dam was taken out approximately 35 years ago. Historical information was provided by the local individuals attending the first meeting in accordance to the creation of the Larks Lake Watershed Plan. There is one site monitored by LTBB on Larks Lake.

B. Tribal Use and Lake Management

LTBB has collaborated in the Larks Lake Watershed Planning Project Watershed Plan. Tip of the Mitt Watershed Council has written the plan with a list of goals, objectives, non-point source pollution concerns, priority pollutants of concern, recommended best management practices and actions, and educational components. A copy of the plan is available at <http://www.watershedcouncil.org/water%20resources/local%20watersheds/larks%20lake%20watershed/files/Larks%20Lake%20Watershed%20Plan.pdf>.

The LTBB draft primary use is primary contact recreational. The LTBB draft designated uses are indigenous aquatic life and wildlife and warm water fishery. According to the most recent 2005 survey completed by the MDNRE fish found in Larks Lake included: 89% rough fish such as white suckers and bullheads, 7% panfish community; pumpkinseed, and rock bass, and the rest being of game fish community; largemouth bass, northern pike, yellow perch, and smallmouth bass (Resources, Larks Lake, Emmet County, 2006). As a result of this survey, no further management for fisheries was recommended by the MDNRE at that time. Wildlife observed but not limited to LTBB NRD staff are bald eagles, terns, and a pair of feeding loons.

Due to concern and interest of the Larks Lake community, Tip of the Mitt Watershed applied for a grant through the Petoskey-Harbor Springs Area Community Foundation to conduct studies in order to determine whether or not fish enhancement projects could be deemed applicable on Larks Lake. Tip of the Mitt Watershed created a committee in which LTBB NRD staff were active to discuss results and recommendations on enhancing fish communities and populations. Recommendations were discussed such as creating brush shelters, putting in log cribs, and/or propagating and establishing aquatic plant communities. Current status of this project was not known at the time of the submission of this report. WQS will contact Tip of the Mitt Watershed for an update and status of this project. Other concerns verbalized by the Larks Lake community were decreasing water depths and thickness of muck. These concerns can contribute to the marl composition of the lake, changing climate conditions, environmental or ecological impacts, and natural lake succession.

C. 2009 Tribal Use Attainment

In 2009, all parameters were within threshold criteria to fully support the primary use of primary contact recreational. The designated uses of indigenous aquatic life and wildlife and warm water fishery will need further evaluation due to a depletion of oxygen during the winter monitoring event in 2009.

D. Parameter Results & Baseline Analysis

1. Dissolved Oxygen

Table 1. Dissolved Oxygen in mg/L

2001-2009 (Odd Years Only)	Results in mg/L	Date
Minimum	1.75	2/13/2009
Maximum	11.82	10/16/2007
Mean	9.17	
Median	8.91	

Based solely on the 2009 dissolved oxygen (DO) winter data result, a winterkill may have occurred that year. In collaboration with Tip of the Mitt Watershed Council's fish enhancement project, winter DO readings were taken by Tip of the Mitt staff in 2010. The 2010 winter average was gathered from readings taken at three different depths: 0.3, 1.3, & 2.6. Readings were consistently 11.96 mg/L. Other waterbodies similar in depth, parameter results, and substrate composition monitored by LTBB during the winter in 2010 displayed similar results in DO concentrations. The mild winter and sunny days created optimal conditions for winter algal blooms and reduced chances of winterkills. The next winter sampling event will be in 2012.

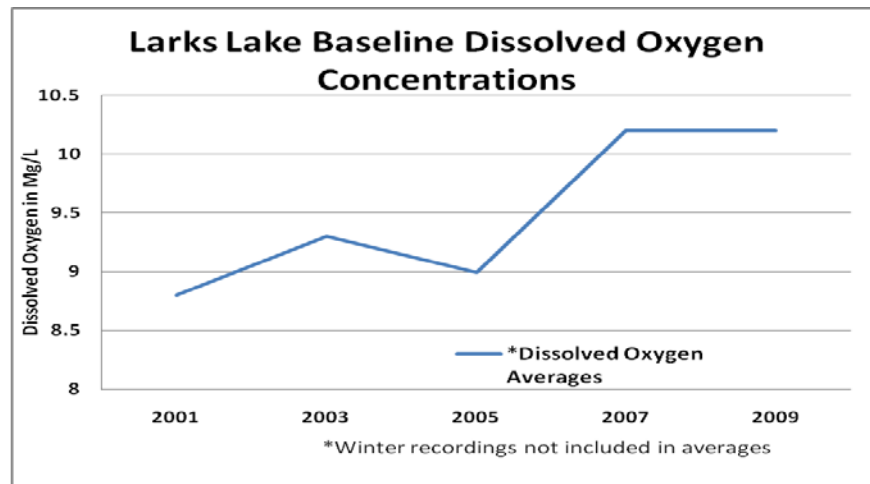


Figure 16. There is a significant trend of dissolved oxygen increasing over time ($R^2=0.77$).

2. Temperature

Table 2. Temperature in °C

2001-2009 (Odd Years Only)	Results in °C	Date
Minimum	4.5	2/13/2009
Maximum	25.8	6/14/2007
Mean	19.06	
Median	21.6	

Unlike dissolved oxygen there was not a significant trend of decreasing temperatures over time. For the majority of fish species dominating Larks Lake, white suckers and bullheads, the temperature ranges fully support all life cycles of these fish. The spawning threshold for largemouth bass was used for analyzing temperature support for game fish species. The spawning threshold was chosen because it had the lowest temperature criterion between the three life cycles of largemouth bass. The 2005 temperature average exceeded the threshold criterion for spawning but not for embryo survival or growth. Although, there was a yearly average exceedence it appears that solely based on temperature game fish species could be managed, see Figure 17. It is important to note that temperature recordings are only taken once a month during the warmer periods of the day. Therefore, these averages do not reflect daily variation of temperature or areas of cover.

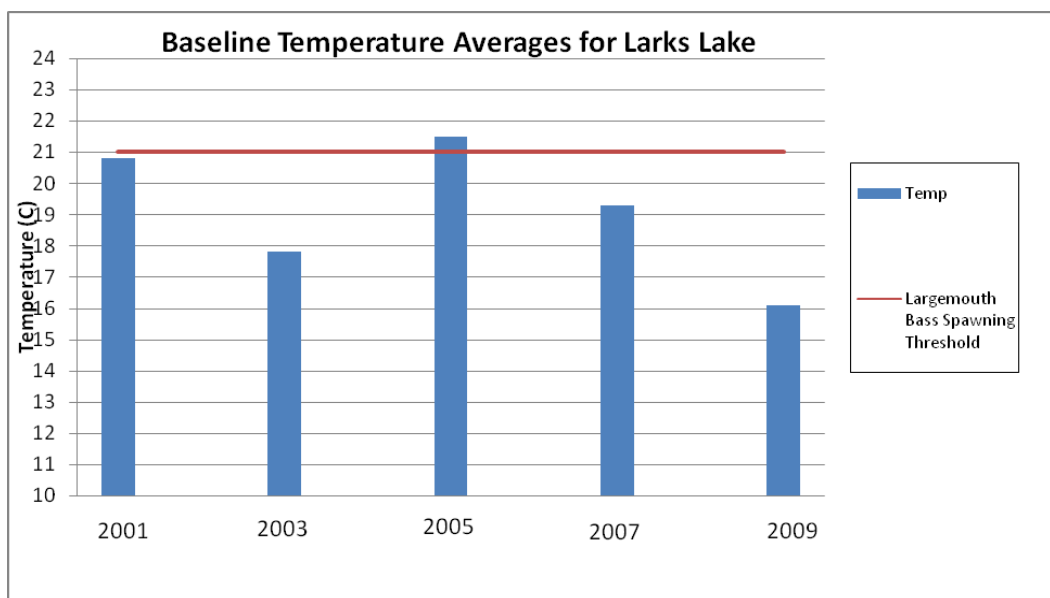


Figure 17: Baseline Temperature Averages for Larks Lake

3. Conductivity

Table 3. Conductivity µg/L

2001-2009 (Odd Years Only)	Results in µg/L	Date
Minimum	189.9	8/23/2001
Maximum	352.6	2/13/2009
Mean	219.1	
Median	214.9	

The conductivity pattern for Larks Lake is similar to all other shallow hardwater lakes and experiences increasing conductivity in the winter versus any other season. There was a significant trend ($R^2=0.86$) that yearly conductivity average has increased over time. See Figure 18.

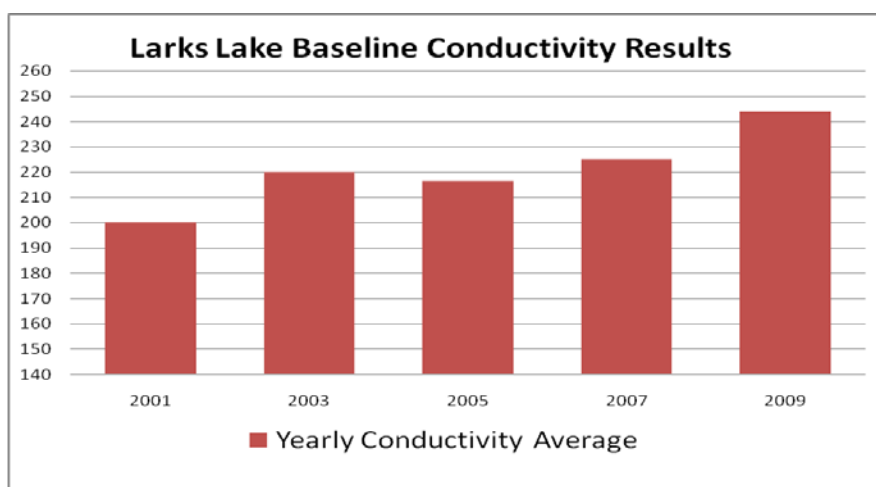


Figure 18: Larks Lake Baseline Conductivity Results

4. Chloride

Table 4. Chloride mg/L

2001-2009 (Odd Years Only)	Results in mg/L	Date
Minimum	0.99	6/10/2003
Maximum	9.4	9/10/2003
Mean	4.3	
Median	4	

There was a significant trend ($R^2=0.75$) that chloride has increased over the duration the baseline assessment, see Figure 19. Future data will be analyzed to interpret whether or not this trend continues. However, the chloride concentrations are still low in terms of affecting the support of any of the Tribal designated uses for this water body.

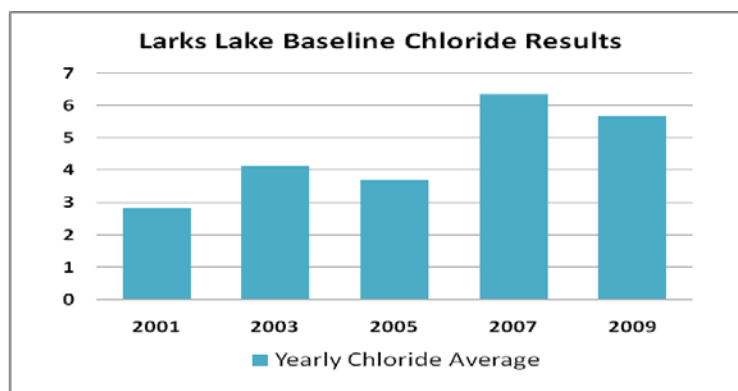


Figure 19: Larks Lake Baseline Chloride Results

Statistical analysis using the Pearson Product Moment Correlation was completed using conductivity and chloride baseline results resulting in a P value supporting a correlation that when one of these variables increase so does the other.

5. pH

Table 5. pH units

2001-2009 (Odd Years Only)	pH Results	Date
Minimum	7.45	2/13/2009
Maximum	9.15	8/9/2005
Mean	8.6	
Median	8.66	

The maximum reading is the only result not within the acceptable range of 6.5-9 pH units. The exceedance is minimal and is not unusual for a marl lake. In conclusion, this exceedance is not of concern to water quality conditions and/or use support. There is a significant trend ($R^2=0.87$) that pH readings have decreased over the time of the baseline assessment, see Figure 20. The range in decreasing results is minimal.

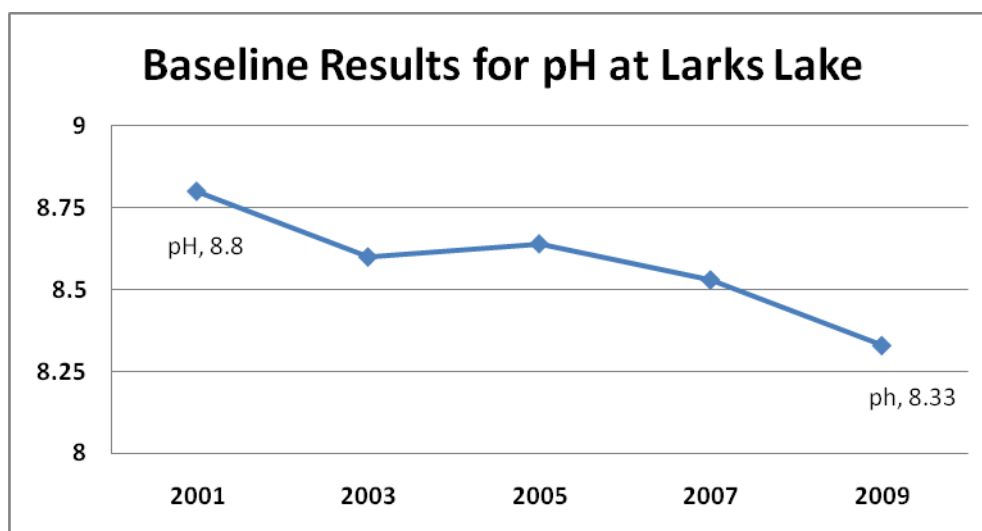


Figure 20: Baseline Results for pH at Larks Lake

6. Total Phosphorus

Table 6. Phosphorus in $\mu\text{g/L}$

2001-2009 (Odd Years Only)	Results in $\mu\text{g/L}$	Date
Minimum	4.6	2/13/2009
Maximum	17	6/14/2008
Mean	9.41	
Median	9.4	

These baseline results are within the range found in unpolluted waters.

7. Total Nitrogen

Table 7. Total Nitrogen in mg/L

2001-2009 (Odd Years Only)	Results in mg/L	Date
Minimum	0.3	8/20/2003
Maximum	1.13	6/10/2003
Mean	0.68	
Median	0.67	

These baseline results are within the range found in unpolluted waters.

8. Chlorophyll *a*

Table 8. Chlorophyll *a* in $\mu\text{g/L}$

2001-2009 (Odd Years Only)	Results in $\mu\text{g/L}$	Date
Minimum	0.57	10/5/2005
Maximum	3.32	10/16/2007
Mean	1.6	
Median	1.5	

The baseline chlorophyll *a* results are low and what would be suspected in a marl lake with low productivity.

9. *E. coli* Bacteria

E. coli bacteria monitoring is implemented by the Northwest Michigan Community Health Agency. The beach area known as Pioneer Park was monitored weekly in 2010 during the swimming season, June 1st through August 6th. There were no beach closures in 2010 at Larks Lake.

10. Habitat Assessment

The score for the habitat assessment completed in 2007 was 130 and the score in 2009 was 138. An increased score would indicate better habitat conditions for indigenous aquatic life and wildlife and/or fisheries. However, this increase in score is probably due to different NRD staff conducting the survey. This lake has been minimally impacted by development, is deemed low in productivity, has minimal aquatic vegetation, and is considered a marl lake.

11. Macroinvertebrates

The comparison of macroinvertebrate results for the metrics calculated vary in terms of determining an increase or decrease to perturbation. The dominant taxon and diversity score indicate a decrease in perturbation. This is determined by analyzing if there is a trend in a decreasing percentage of dominant taxon and an increasing diversity score over time. Both had high R values associated to the trendlines. There was trend of an increase of the percentage of oligochaetes which would indicate an increase in perturbation. The percentage of ephemeroptera, plecoptera, and odonata (%EPO) orders were 0 percent in 2007 however, there was not a trend indicated for a total decrease over time. The percentages of the more sensitive orders (%EPO) are fairly low throughout the baseline with the maximum percentage being 5.08% in 2003. 2009 results will be analyzed to see if the trends continue and whether or not there is at least some percentage of EPO orders found in Larks Lake.

E. Conclusion and/or Recommendations

The baseline results are what would be expected in a marl hard water lake with low productivity. The minimal diversity and composition of vegetation and type is also what would be typically found in a marl lake. The substrate visually is characteristic of a marl lake, being a grey with variable amount of clay. This lake will be part of a substrate study to determine the percentage of marl in the lake at randomly chosen sites. This data will be compared to Wycamp/Spirit and O'Neal Lake substrate data as well as all other data collected between these three water bodies. Larks Lake does not have the diversity in aquatic vegetation as the other two lakes in the study. The vegetation that Larks Lake does have precipitates calcium carbonate in the late summer months.

The WQS will recommend that NRD Inland Fisheries staff conduct a fish survey so that results of the 2006 MDNRE survey can be compared with current data and determine whether or not there have been changes in fish diversity and population counts. The WQS will also get updated by Tip of the Mitt Watershed Council staff on the status of fish enhancement projects on the lake. The WQS will meet with Tribal Cultural Advisor and elders to determine cultural significance of the lake and if there are cultural or ceremonial uses still practiced at this lake.

5. Spring Lake

A. Description and Background

Spring Lake also known as Mud Lake has two arms, the South and North arm. These arms are separated by a road and a park with a boardwalk through an adjacent wetland area. This lake is located adjacent to M-119, a highly used road from the city of Petoskey to Harbor Springs. On the north side of the South Arm there is a steep slope that is forested and on top of this slope are condominiums. There is only one residential home on the north arm, however, these lake arms are surrounded by infrastructure: roads, commercial buildings, condominiums, or park facilities. Both arms are shallow in depth, with the south arm having a surface area of 6.7 acres and the north arm consisting of a 10.1 acre surface area. The lakes could be classified as ponds due to their size and characteristics. The water level is controlled by a water structure between the two arms to prevent flooding. There is a monitoring site on each arm.

B. Tribal Use and Lake Management

Both arms have been designated as a primary Tribal use of indigenous aquatic life and wildlife. Other designated uses include warm water fishery and primary contact recreational.

Spring Lake's township, Bear Creek, began stocking fish in the south arm in May of 2007. At that time, the fish species being stocked were: hybrid sunfish, largemouth bass, and fathead minnows. It is unknown whether or not the township is still stocking the lake and if the same species are being stocked or whether or not additional species are being stocked. The MDNRE are responsible for approving fish stocking permits in this lake.

C. 2009 Tribal Use Attainment

All Tribal uses are fully supported. The narrative description of Part 4 of the Michigan Water Quality Standards Rule 51 states that the Great Lakes and connecting waters shall not exceed 50 milligrams per liter as a monthly average for chloride. Both arms of Spring Lake exceeded 50 mg/L during monitoring events in the 2009 field season. However, the Michigan standards definition of connecting waters has to be a direct connection as clarified by Michigan Department of Natural Resource and the Environment staff. Spring Lake does hydrologically connect to the inland waterway but not directly by definition of MDNRE. Temperature thresholds exceed optimum spawning conditions for largemouth bass during some months of the monitoring season; however, they never exceed embryo or growth thresholds.

D. Parameter Results & Baseline Analysis

Statistics will be displayed separately for each arm since they are separated by a wetland, a road, and have a water control structure between them.

1. Dissolved Oxygen-Spring Lake South Arm

Table 1. Dissolved Oxygen in mg/L

2001-2009 (Odd Years Only)	Results in mg/L	Date
Minimum	1.27	2/10/2009
Maximum	16.75	6/17/2009
Mean	11.24	

Median	11.52	
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The minimum DO reading would support the criteria indicating a winter fish kill. In the 2011 winter season a bubbler was observed by LTBB water staff on the fish platform present on the south arm. This bubbler will keep oxygen levels at a higher concentration. It is unknown whether or not the bubblers were put in for this purpose or were installed to avoid damage to the deck from ice cover. The month that maximum concentration for dissolved oxygen occurred is also the maximum result for chlorophyll *a*. This supersaturated result and the correlation between chlorophyll *a* supports an algal bloom at the time of the monitoring event.

1. Dissolved Oxygen-Spring Lake North Arm

Table 1. Dissolved Oxygen in mg/L

2001-2009 (Odd Years Only)	Results in mg/L	Date
Minimum	1.1	2/10/2009
Maximum	15.65	6/18/2003
Mean	9.79	
Median	9.65	

The minimum result was also taken during the winter sampling event in 2009, indicating the possibility of a winter fish kill. This maximum result is not comparable to the south arm's maximum result date and is not comparable to a high chlorophyll *a* concentration during this monitoring event.

2. Temperature- Spring Lake South Arm

Table 2. Temperature in °C

2001-2009 (Odd Years Only)	Results in °C	Date
Minimum	2.87	2/10/2009
Maximum	26.51	7/19/2005
Mean	19.77	
Median	21.7	

2. Temperature-Spring Lake North Arm

Table 2. Temperature in °C

2001-2009 (Odd Years Only)	Results in °C	Date
Minimum	4.48	2/10/2009
Maximum	26.06	7/19/2005
Mean	18.76	
Median	19.41	

These dates for the minimum and maximum in terms of temperature are the same for both arms of the lake. As mentioned in the Tribal use attainment there were monitoring events that exceed largemouth bass optimum spawning in the 2009 field season however, the mean was below the threshold every year for both arms. The optimal temperatures for largemouth bass spawning are 21°C or less.

3. Conductivity-Spring Lake South Arm

Table 3. Conductivity µg/L

2001-2009 (Odd Years Only)	Results in $\mu\text{g/L}$	Date
Minimum	2.2	7/14/2003
Maximum	1190	2/10/2009
Mean	470.9	
Median	478.8	

The maximum result is higher than any other conductivity result for all water bodies monitored. This winter concentration may be due to the lakes close proximity to M-119, a highly used and traveled road and de-iced frequently during the winter. There was a significant trend ($R^2=0.95$) that the yearly conductivity average has increased over time. See Figure 21.

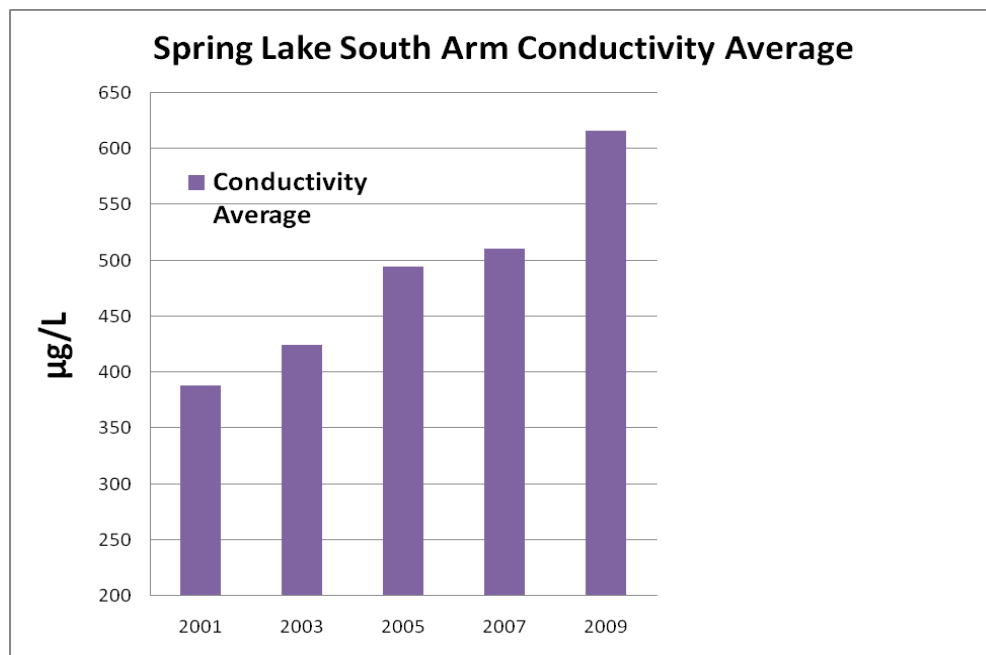


Figure 21: Spring Lake South Arm Conductivity Average

3. Conductivity-Spring Lake North Arm

Table 3. Conductivity $\mu\text{g/L}$

2001-2009 (Odd Years Only)	Results in $\mu\text{g/L}$	Date
Minimum	452.1	7/16/2001
Maximum	819.4	2/10/2009
Mean	512.97	
Median	506.3	

There was a significant trend ($R^2=0.75$) that the yearly conductivity average has increased over time. See Figure 22.

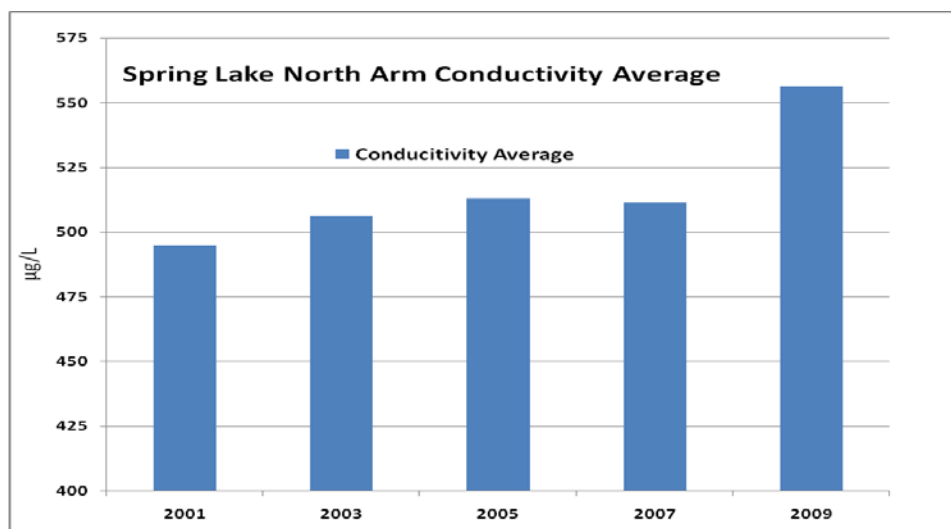


Figure 22: Spring Lake North Arm Conductivity Yearly Average

Both arms of the lake are also following the trend of an increase in conductivity during the winter as seen at other lakes.

4. Chloride-Spring Lake South Arm

Table 4. Chloride mg/L

2001-2009 (Odd Years Only)	Results in mg/L	Date
Minimum	24.9	9/24/2003
Maximum	214	2/10/2009
Mean	45.73	
Median	42.6	

There was a significant trend ($R^2=0.86$) that the chloride concentrations have increased over time.

4. Chloride-Spring Lake North Arm

Table 4. Chloride mg/L

2001-2009 (Odd Years Only)	Results in mg/L	Date
Minimum	39.94	10/26/2005
Maximum	105.7	2/10/2009
Mean	49.6	
Median	50.6	

There was a significant trend ($R^2=0.92$) that the chloride concentrations have increased over time. See Figure 23 for a bar chart displaying these increases for both arms.

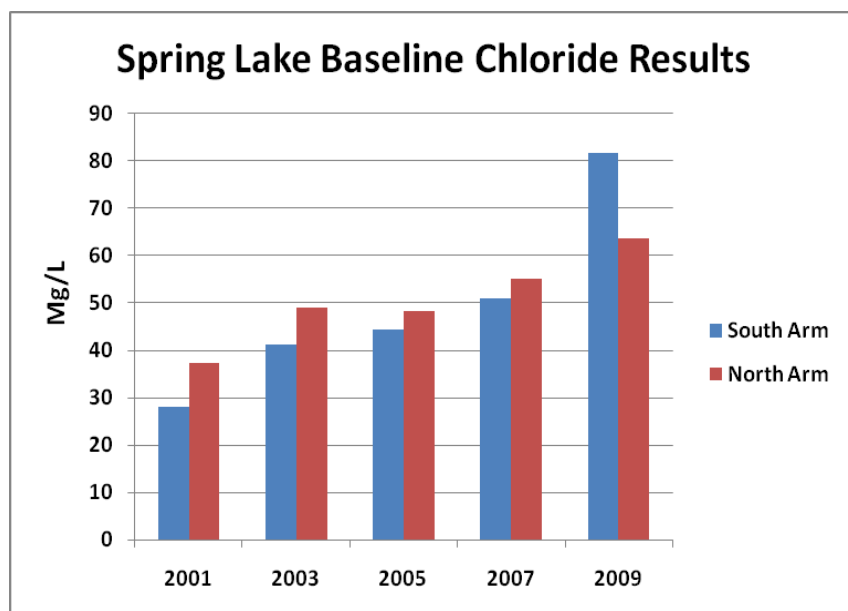


Figure 23: Spring Lake Baseline Chloride Results

The north arm predominately has a higher concentration of chloride than the south arm except in 2009. Statistical analysis using the Pearson Product Moment Correlation was completed using conductivity and chloride baseline results resulting in a P value supporting a correlation that when one of these variables increase so does the other. Spring Lake has the highest chloride concentrations of any other lake monitored by LTBB. Although the chloride results are the highest they are still minimal in their detriment to indigenous aquatic life and wildlife, being below the Federal exceedence criteria established by U.S EPA for Aquatic Life, 230 mg/L (Office of Water, 1988).

5. pH-Spring Lake South Arm

Table 5. pH units

2001-2009 (Odd Years Only)	pH Results	Date
Minimum	7.58	10/26/2005
Maximum	8.65	6/17/2009
Mean	8.16	
Median	8.21	

5. pH- Spring Lake North Arm

Table 5. pH units

2001-2009 (Odd Years Only)	pH Results	Date
Minimum	7.33	2/10/2009
Maximum	8.38	6/14/2001
Mean	8.05	
Median	8.07	

All baseline results are within Michigan State Water Quality Standards 6.5-9 range.

6. Total Phosphorus-Spring Lake South Arm

Table 6. Phosphorus in µg/L

2001-2009 (Odd Years Only)	Results in µg/L	Date
Minimum	1.3	8/11/2003
Maximum	25.2	6/21/2005
Mean	10.25	
Median	9.8	

6. Total Phosphorus-Spring Lake North Arm

Table 6. Phosphorus in µg/L

2001-2009 (Odd Years Only)	Results in µg/L	Date
Minimum	4.4	7/10/2007
Maximum	21.9	7/14/2003
Mean	11.13	
Median	11.2	

These baseline results are within the 10-50 µg/L range that would be found in unpolluted waters.

7. Total Nitrogen-Spring Lake South Arm

Table 7. Total Nitrogen in mg/L

2001-2009 (Odd Years Only)	Results in mg/L
Minimum	0.51
Maximum	1.81
Mean	0.87
Median	0.86

The minimum total nitrogen result was recorded in 2005 on August 16th and the maximum result was recorded in 2003 on June 18th.

7. Total Nitrogen-Spring Lake North Arm

Table 7. Total Nitrogen in mg/L

2001-2009 (Odd Years Only)	Results in mg/L	Date
Minimum	0.54	9/14/2009
Maximum	1.73	10/4/2001
Mean	0.93	
Median	1.00	

Total nitrogen results for both arms are comparable in range and are within the limit found in unpolluted waters.

8. Chlorophyll *a*-Spring Lake South Arm

Table 8. Chlorophyll *a* in µg/L

2001-2009 (Odd Years Only)	Results in µg/L	Date
Minimum	.2	6/18/2003
Maximum	8.33	6/17/2009
Mean	2.26	
Median	1.34	

The maximum result corresponds with the maximum dissolved oxygen reading taken during this monitoring event, indicating an algal bloom. There was a significant trend ($R^2=0.75$) that the chlorophyll *a* concentrations have increased over time.

8. Chlorophyll *a*-Spring Lake North Arm

Table 8. Chlorophyll *a* in µg/L

2001-2009 (Odd Years Only)	Results in µg/L	Date
Minimum	0.2	7/14/2003
Maximum	4.33	8/20/2009
Mean	1.48	
Median	1.24	

Both arms are less than 10 µg/L creating a clear lake however, this lake is not a recreational lake. Maximum thresholds would depend on the health of indigenous aquatic life and wildlife within the lake. There was a significant trend ($R^2=.089$) that the chlorophyll *a* concentrations have increased over time in the north arm. Please see Figure 24 for the chlorophyll *a* baseline results.

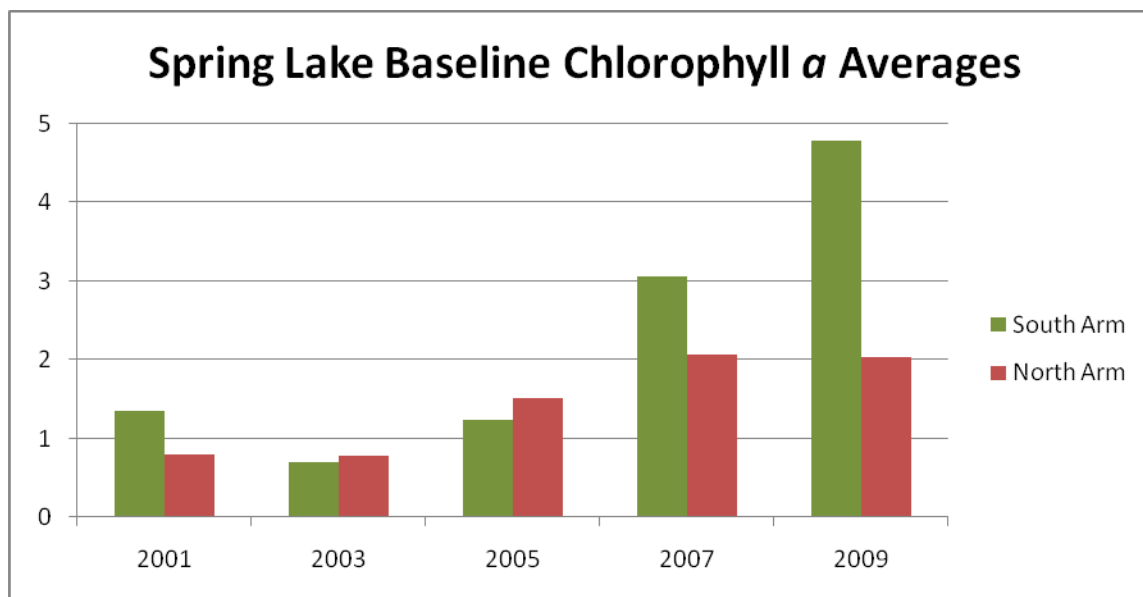


Figure 24: Spring Lake Baseline Chlorophyll *a* Averages

LTBB will continue to monitor this trend, detect algal blooms, and whether or not this trend has an adverse effect on the overall health and diversity of aquatic life and wildlife in future monitoring years.

9. *E. coli* Bacteria

E. coli bacteria samples are not taken at Spring Lake by the NMCHA. These sites were not identified by LTBB as sites of priority for future *E. coli* bacteria testing. A host of waterfowl use this lake as habitat so *E. coli* bacteria strains are probable in this lake, however swimming is not a use and is unfavorable due to the vegetation and deep mucky bottom.

10. Habitat Assessment

The score for the habitat assessment completed in 2007 was 109. Only one assessment was completed for both arms. In 2009, an assessment was completed for each arm. Since there is a water control structure between these two arms, conducting an assessment on each arm is more appropriate. LTBB was unaware of the water control structure at the time of the 2007 habitat assessment. LTBB WQS became aware of the structure when informed by the Bear Creek Township Supervisor in 2008. The scores from 2007 cannot be compared with the scores of 2009. The score for Spring Lake's south arm was 118 and for the north arm the score was 108. The habitat parameter with a varied score was watershed road condition and hydrological alteration. The north arm has an area with more erosion and pollution potential near the adjacent road and the south arm has been altered from its natural depth by some dredging in the past.

11. Macroinvertebrates

There were no trends for any of the metrics calculated to indicate an increase or decrease in perturbation. See the Table 11 below for percentages and scores related to the grab samples taken at Spring Lake.

Table 11: Macroinvertebrate Scores and Percentages

	Diversity Score	% Oligochaetes	% Dominant Taxon	% EPO
2001	3.14	2.21	9.78	4.73
2003	2.83	10.34	17.24	20.7
2005	3	0.74	11.8	11.8
2007	2.86	4.35	14.13	9.78

E. Conclusion and/or Recommendations

The LTBB WQS will follow up with the Bear Creek Township Supervisor to discuss whether or not fish stocking has continued in the south arm. The LTBB Water Quality Assessment Report will be shared with the Supervisor. Although, chlorophyll *a* concentrations are minimal, they are increasing over time as well as chloride and conductivity concentrations. The fish stocking may cause increased algal blooms and the heavy salting may continue to increase conductivity and chloride results. As mentioned, the LTBB WQS will continue to assess all parameter results and the increasing trends over time. If future data analysis indicates that overall health of the aquatic life and wildlife are being impacted, the LTBB WQS will notify the township and MDNRE to discuss solutions.

6. Wycamp/Spirit Lake

A. Description and Background

Spirit Lake is a shallow 609 acre lake located in the town of Cross Village in Northern Emmet County. The area surrounding Spirit Lake is primarily forested and forested wetland. The majority of the land that surrounds Wycamp Lake is owned by the State of Michigan, approximately 200 acres is owned by a private land owner, and over 400 acres of the land surrounding Spirit Lake is used for a private hunting preserve.

The two townships Spirit Lake encompasses are densely populated by LTBB citizens. The lake and adjacent grounds are used for ceremonies, hunting, fishing, and gathering by the Odawa people. Natural resources are gathered for food, ceremonies, art and crafts, and medicinal practices. The lake area was and still may be used as a meeting place for Odawa elder gatherings. A historical & cultural land use report was completed on July 25, 2006 by Wes Andrews. This report includes an inventory of historical information, cultural resources, and recommendations for the management of Spirit Lake. According to a Tribal use questionnaire given to community members at a 2008 annual community meeting, Spirit Lake is the third most used lake out of lakes monitored by the LTBB water quality monitoring program. It had the highest rank for cultural/ceremonial use by Tribal citizens.

The historical community encompassing Spirit Lake known as Wycamp Creek Village is eligible to be listed in the National Register of Historical Places due to the cultural resources it provides. This area and the outlet, Wycamp Creek was used as part of a sawmill operation years ago, known as the Wycamp Sawmill.

There is one monitoring site on Spirit Lake.

B. Tribal Use and Lake Management

The LTBB NRD has written a management plan for Spirit Lake. As quoted in the Wycamp Management Plan, "The goals of the Natural Resource Department are to manage fisheries and wildlife populations for the benefit of Tribal members for the next seven generations. With this in mind, the Tribe will make recommendations on management that will help protect the natural resources of Spirit Lake. The overall goal of this lake plan is to apply an ecosystem management system approach that recognizes the interrelated nature of air, land, water and all life. This watershed approach is intended to include the whole system and focus on the interrelationships of the lake environment and the biotic communities."

With this management approach in mind the Tribal primary use is cultural/ceremonial. Other designated uses include primary contact recreational, wild rice area, warm water fishery, and indigenous aquatic life and wildlife.

Management issues in the past have been related to water quantity versus water quality. Water levels and dam control have been a priority concern to LTBB citizens and the surrounding community. In 1960, a court-ordered water level was instated on Spirit Lake. The water level should be no more than 611.0 feet above mean sea level in winter and 611.8 feet above mean sea level in summer (Jansma 1960). LTBB NRD has put two staff gages in the lake to monitor lake levels. Staff gauges are located at the dam and the north boat launch. These staff gauges allow LTBB NRD to monitor water fluctuations and the effects on aquatic life, fish, wildlife and wild rice growth.

Wild rice has been planted at Spirit Lake every year since 2006 by the LTBB NRD. The LTBB WQS has not discussed whether or not these plantings will continue in the future or how success is being measured.

C. 2010 Tribal Use Attainment

Cultural/ceremonial, primary contact recreational, warm water fishery, and indigenous aquatic life and wildlife were fully supported in terms of parameter results. Optimum largemouth bass spawning temperature thresholds were exceeded in May, July, and August of 2010 however, embryo and growth thresholds were not. Monitoring was conducted during the hottest times of the daily temperature cycle and past fish surveys conducted by NRD inland fisheries biologists support a sufficient warm water fishery. The use of Spirit Lake as a wild rice area will need further evaluation.

D. Parameter Results & Baseline Analysis

1. Dissolved Oxygen

Table 1. Dissolved Oxygen in mg/L

2000-2010 (Even Years Only)	Results in mg/L	Date
Minimum	5.44	6/12/2002
Maximum	16.42	2/8/2010
Mean	9.13	
Median	8.9	

The alternate Hach Sonde was taken to Spirit Lake on February 9th to assure that the result recorded on February 8th was correct and not an outlier due to equipment malfunction. The results were even higher than the maximum result at 18 mg/L. This supports the indication that a winter algal bloom was taking place.

2. Temperature

Table 2. Temperature in °C

2000-2010(Even Years Only)	Results in °C	Date
Minimum	3.51	2/8/2010
Maximum	26.8	5/25/2010
Mean	18.2	
Median	20.1	

The abundance and dominant type of fish caught during the years of 2002-2006 during LTBB NRD fish assessments were variable by year and by type of net and/or equipment used to assess the fishery. However an overall assessment of all years combined resulted in Bluegill being the most abundant, largemouth bass, the second, and smallmouth bass, the third. Other fish caught include; rock bass, brown bullhead, yellow perch, and pumpkinseed, common carp, common shiners, bluntnose minnows, sand shiners, and johnny darters comprised less than one percent of the fish community. Temperature assessment was based on the spawning, embryo and optimum growth weekly averages as illustrated in Appendix 4. As seen below in Figure 25, yearly average temperatures did not exceed optimum spawning thresholds. Winter temperature readings were not included in these averages.

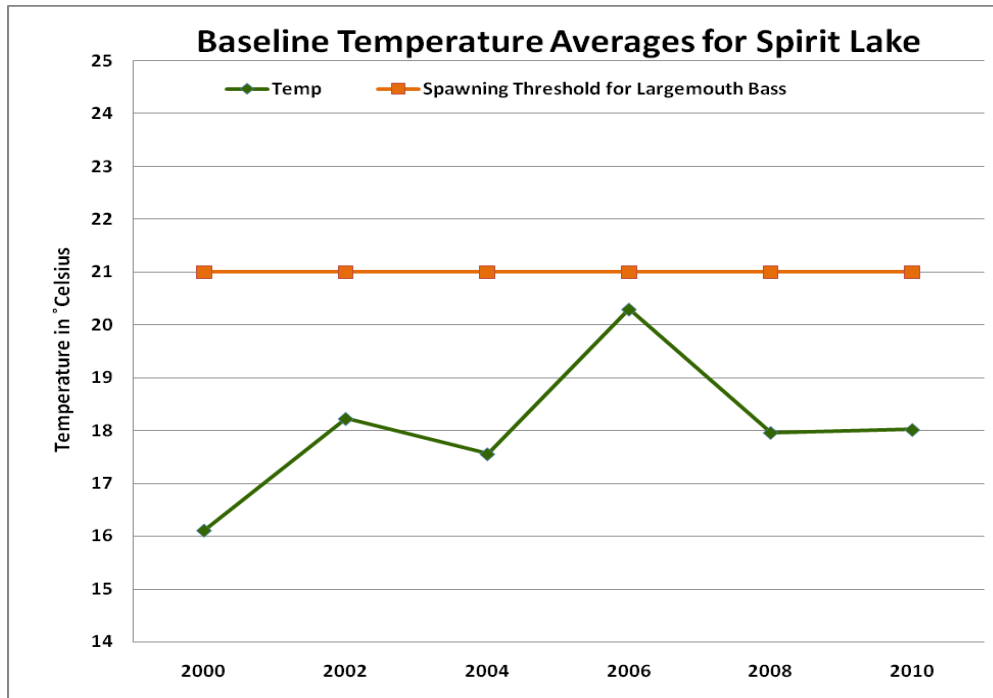


Figure 25: Baseline Temperature Averages for Spirit Lake

3. Conductivity

Table 3. Conductivity $\mu\text{g/L}$

2000-2010 (Even Years Only)	Results in $\mu\text{g/L}$	Date
Minimum	206.4	5/4/2004
Maximum	383.4	2/8/2010
Mean	272.24	
Median	273.6	

High conductivity readings in Spirit Lake during the winter monitoring event follow the same pattern of other lakes with similar physical characteristics.

4. Chloride

Table 4. Chloride mg/L

2000-2010 (Even Years Only)	Results in mg/L	Date
Minimum	1.3	9/16/2004
Maximum	5.64	9/21/2008
Mean	3.40	
Median	3.13	

These low concentrations can be contributed to the lake's remote location, a shoreline vegetation buffer, and only two primitive non-paved boat launches.

5. pH

Table 5. pH units

2000-2010 (Even Years Only)	pH Results	Date
Minimum	7.9	5/3/2004
Maximum	8.8	9/3/2010
Mean	8.42	
Median	8.45	

The maximum range can be contributed to precipitation of calcium carbonate. These pH results are within the range of 6.5-9 set by the State of Michigan. This higher range of pH is a characteristic of a marl hard water lake.

6. Total Phosphorus

Table 6. Phosphorus in µg/L

2000-2010 (Even Years Only)	Results in µg/L	Date
Minimum	2.4	5/3/2004
Maximum	14	2/8/2010
Mean	8.53	
Median	8.4	

The baseline total phosphorus results were within the 10-50 µg/L range found in unpolluted waters.

7. Total Nitrogen

Table 7. Total Nitrogen in mg/L

2000-2010 (Even Years Only)	Results in mg/L	Date
Minimum	0.27	10/11/2001
Maximum	1.11	07/22/2008
Mean	0.63	
Median	0.66	

Baseline results are low and are expected in unpolluted waters.

8. Chlorophyll *a*

Table 8. Chlorophyll *a* in µg/L

2000-2010 (Even Years Only)	Results in µg/L	Date
Minimum	0.16	6/12/2002
Maximum	8.32	5/3/2004
Mean	1.56	
Median	1.28	

The reading on May 3rd is also the maximum result for total phosphorus. The baseline results indicate that chlorophyll *a* concentrations are fairly low when considering the mean and the median.

9. *E. coli* Bacteria

E. coli bacteria samples are not taken at Spirit Lake by the Northwest Michigan Community Health Agency. A host of waterfowl use this lake as habitat so *E. coli* bacteria strains are probable in

this lake. However, swimmers have never been observed by water quality staff. NMCHA may find that this lake is too remote, too unpopulated, they may have funding constraints that would also fail to justify testing.

10. Habitat Assessment

The score for the habitat assessment completed in 2008 was 122 and the score in 2010 was 125. These scores are fairly close and may just be a difference based on assessor's interpretation. Habitat concerns all correspond with water levels. Since this lake has a legal lake level and hasn't been monitored until the staff gauges were installed, LTBB NRD now have better capability to see how lake levels affect wildlife, aquatic life, and the fishery. There has also been a change in the responsible regulator from County Controller to the adjacent private landowner. One positive aspect of monitoring and the collaborative effort to control the lake level is the prevention of a loon nest from flooding (Division, 2008). One of the landowners who has property along Spirit Lake contacted the LTBB NRD Wetlands Specialist to assist him in identification of a possible stand of invasive *Phragmites australis*. The invasive *Phragmites australis* was positively identified near and in an inlet to Spirit Lake in 2010. Treatment options for the stand were recommended to the landowner. Whether or not the landowner treated the stand was unknown at the time of the completion of this assessment.

10. Macroinvertebrates

2008 macroinvertebrates have been sorted but not identified. Therefore, metrics and a diversity score has not been calculated for 2008. 2008 macroinvertebrate data will be available in the next water quality assessment report. Data for past years has shown a decrease in diversity, a decrease in orders that are more sensitive to pollution, and an increase in oligochaetes that tend to be pollution tolerant. Please see Figure 26 for a bar chart illustrating the decrease in the percentage of Ephemeroptera, Odonata, and Plecoptera orders.

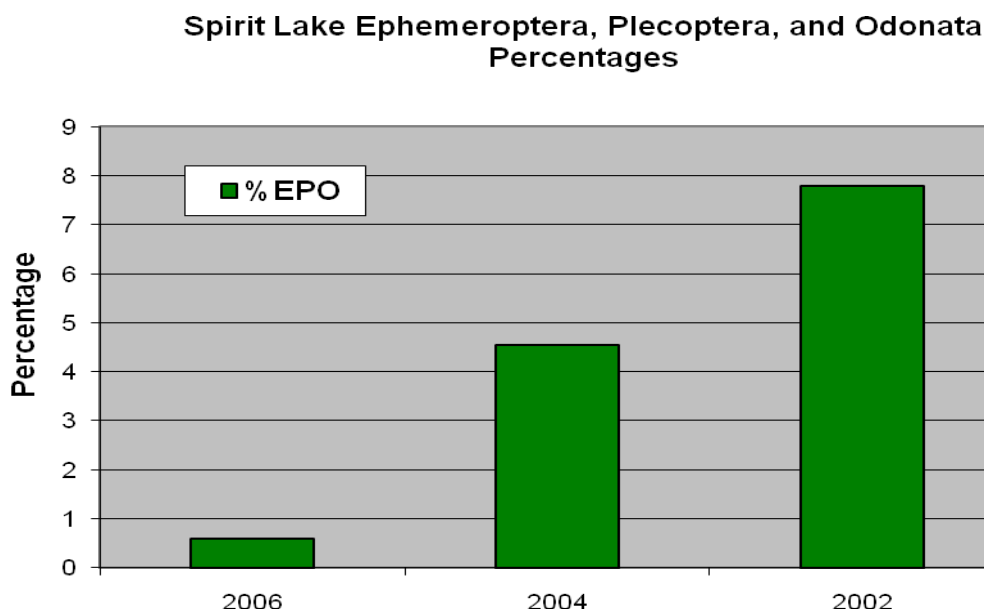


Figure 26: Spirit Lake Ephemeroptera, Plecoptera, and Odonata Percentages

2008 results will be compared with past years to see if these metric trends continue.

E. Conclusion and Recommendations

Due to the Odawa's traditional and cultural reliance on Spirit Lake, this waterbody will be monitored every two years on a seasonal basis. Winter sampling will occur every year for physical parameters that can be taken with the Hach Sonde if weather and ice cover is deemed safe. This will be done to monitor for winter fish kills. The water quality monitoring program has added an inlet of Spirit Lake, Collins Creek, to the monitoring design. Collins Creek will be monitored in the same year that Spirit Lake and its outlet, Wycamp Creek, are monitored. This is a watershed approach to monitoring. The LTBB NRD Inland Fisheries and Wildlife programs will also continue to collect brood, fish, eagle, and any other data to enhance our knowledge of the lakes ecosystem as whole. Spirit Lake is one of the lakes where substrate will be sampled in 2011. This data will be compared to O'Neal and Larks Lake substrate data. This substrate data will also be compared to an aquatic vegetation survey conducted by Tip of the Mitt Watershed Council for LTBB NRD on Spirit Lake. This data will be used to improve our understanding of substrate, plant growth, and water interactions and ultimately what management practices and uses that can be successful at Spirit Lake.

The LTBB WQS will follow up with the LTBB NRD Inland Fisheries Biologist on the status of wild rice growth on Spirit Lake and whether or not it will continue to be seeded. The WQS will also get clarification on whether or not LTBB has registered Spirit Lake and the surrounding area (once known as Wycamp Creek Village), to receive National Historical Places recognition. The LTBB WQS will also ask for current data resulting from the staff gauges on Spirit Lake.

7. Crooked Lake

A. Description and Background

Crooked Lake is a part of the 45 mile Inland Waterway. The Inland Waterway begins in Pickerel Lake through the Pickerel Channel, connecting to Crooked Lake. Crooked Lake flows into Crooked River to Burt Lake; from Burt Lake through Indian River, connecting to Mullett Lake; and from Mullett Lake through the Cheboygan River to Lake Huron.

Historically, Odawa people frequently portaged their canoes over the sand dunes near Petoskey to and from Round Lake, and then followed river courses connecting Crooked, Burt, and Mullett Lakes to Lake Huron. This route often began the perilous journey around Lower Michigan's northern tip through the open waters of Lake Michigan and Lake Huron.

According to the results of the LTBB Tribal Uses Questionnaire conducted at the 2008 LTBB community meeting, Crooked Lake was ranked as the second most used lake by Tribal citizens for fishing, swimming, and boating. Although the questionnaire did represent cultural uses at Crooked Lake, questionnaire participants did not indicate this use. However, in recent years, the lake has been used by LTBB citizens for cultural purposes. The lake has been the beginning point for the annual Jiimaan (canoe) crossing. The annual Jiimaan crossing celebrates and recognizes our ancestors' journeys on these waters.

Crooked Lake has two basins with a total surface area of 3,450 acres. The LTBB Water Quality Monitoring Program only monitors at the deepest depth on the west basin. The west basin is 1,642 acres in surface area.

B. Tribal Use and Management

The designated tribal primary use at Crooked Lake is a cold water fishery. Other designated uses include subsistence fishery, indigenous aquatic life and wildlife, cultural/ceremonial, and primary contact recreational.

Most fish inhabiting Crooked Lake are warm water species. These fish include rock bass, yellow perch, bluegill, small and largemouth bass, northern pike, and muskellunge. Walleye also inhabit the lake, but are considered a cool water fish. According to a MDNRE fish assessment completed on Crooked and Pickerel Lakes, walleye appear to grow substantially slower than the state average. However, this difference was likely due, at least in part, to biases between aging methods used by MDNRE (Hanchin, 2005). There is a population of brown trout in Crooked Lake as well. Therefore, it is recommended to maintain temperature and dissolved oxygen levels within thresholds recommended for coldwater species. The last fish stocking data that can be found on the MDNRE Fish Stocking Database for Crooked Lake was June 8th, 2006. 25,000 walleye were stocked on this date. Stocking has since then been suspended in recent years due to Viral Hemorrhagic Septicemia.

C. 2009 Tribal Use Attainment

All uses were fully supported in 2009 at Crooked Lake. Results of oxygen depletion in the hypolimnion and high temperatures in the epilimnion were observed in the summer months at the monitoring site. These exceedences do not cause concern for coldwater and coolwater fish species inhabiting the lake since there are areas of cover and other waterways connected to Crooked Lake for fish to move to during these warm periods of time. This temperature profile is natural and a common occurrence in lakes monitored by LTBB that experience thermal stratification.

D. Parameter Results & Baseline Analysis

Crooked Lake is a dimictic lake that mixes during the spring and fall and thermally stratifies for a short period in the summer. Please see Figure 27.

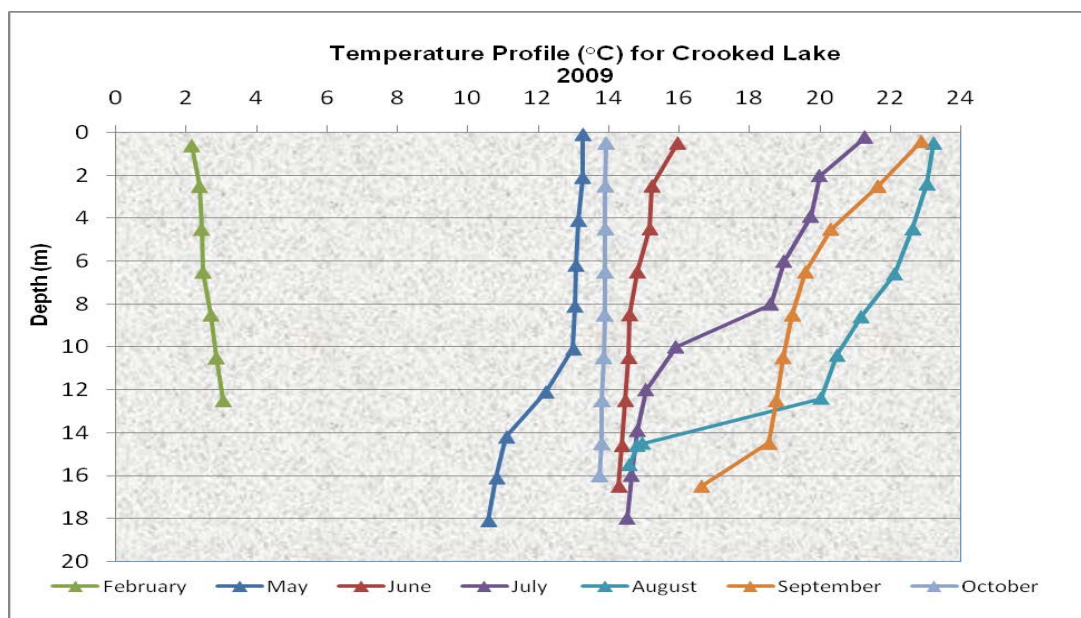


Figure 27: Temperature Profile for Crooked Lake in 2009

1. Dissolved Oxygen

Table 1. Dissolved Oxygen

2001-2009 (Odd Years Only)	Results in mg/L	Date & Depth (meters)
Minimum	0.03	8/24/01 & 13.9
Maximum	12.25	2/11/09 & 0.6
Median	8.73	

A dissolved oxygen mean was not calculated since it would combine each depth layer and would not accurately represent the differences between depth strata. The minimum dissolved oxygen result was taken at 13.9 meters during the height of the summer when mixing is not occurring in the hypolimnion. The lack of oxygen at this depth during stratification is common on this lake and has been seen during August of every year monitored. There is always a sufficient amount of oxygen within the epilimnion for fish, aquatic life, and wildlife.

2. Temperature

Table 2. Temperature

2001-2009 (Odd Years Only)	Results in °C	Date & Depth (meters)
Minimum	2.16	2/11/09 & 0.6
Maximum	25.17	8/8/2005 & 0.4
Median	16.06	

The minimum temperature and maximum dissolved oxygen during the baseline assessment occurred during the 2009 winter sampling event. . The maximum temperature was taken at the height of the summer at the surface. Mean temperature was not displayed due to stratification.

3. Conductivity

Table 3. Conductivity

2001-2009 (Odd Years Only)	Results in µg/L	Date & Depth (meters)
Minimum	279.7	8/24/01 & 6.7
Maximum	374.1	2/11/09 & 12.5
Median	318.1	

The ranges of conductivity results throughout the lake profile were minimal during a sampling event. The baseline range is also minimal for conductivity. Following the same pattern as the shallow lakes the maximum conductivity result was taken during the winter sampling event.

4. Chloride

Table 4. Chloride

2001-2009 (Odd Years Only)	Results in mg/L	Date & Depth (meters)
Minimum	1.8	8/12/03 & .3
Maximum	10.96	7/9/09 & 18
Median	7.8	

Baseline chloride results are low and support all fish, aquatic life, and wildlife. There are no non-point or point source pollution issues concerning chloride in basin of Crooked Lake.

5. pH

Table 5. pH

2001-2009 (Odd Years Only)	pH Results	Date & Depth (meters)
Minimum	7.33	9/27/01 & 11.8
Maximum	8.6	8/8/05 & .4
Median	8.27	

The baseline results are with the recommended 6.5-9 range suitable for all uses.

6. Total Phosphorus

Table 6. Total Phosphorus

2001-2009 (Odd Years Only)	Results in $\mu\text{g/L}$	Date & Depth (meters)
Minimum	2.9	6/2/2005 & .3
Maximum	17	8/12/2003 & 10.3
Median	6.2	

The baseline range for total phosphorus is within what should be found in unpolluted waters. During the summer months, there are higher total phosphorus concentrations in the hypolimnion. A Pearson Product Moment Correlation was performed using dissolved oxygen and total phosphorus as variables for samples taken at the deep or bottom depth. The results indicate that when dissolved oxygen decreases, total phosphorus increases. This may be due to the release of phosphorus from the sediment when oxygen is not present. Sources of excess total phosphorus entering this lake system are presently not a concern at least at the monitoring site in the west basin of Crooked Lake.

7. Total Nitrogen

Table 7. Total Nitrogen

2001-2009 (Odd Years Only)	Results in mg/L	Date & Depth (meters)
Minimum	0.08	6/6/07 & 8.0
Maximum	1.3	8/13/09 & 12.4
Median	0.43	

Baseline total nitrogen concentrations are minimal at this monitoring location. Results are within the 0-5 Mg/L range found in unpolluted waters.

8. Chlorophyll *a*

Table 8. Chlorophyll *a*

2001-2009 (Odd Years Only)	Results in $\mu\text{g/L}$	Date
Minimum	0.11	7/5/07
Maximum	2.32	8/9/07
Median	0.88	

Since Crooked Lake is used primarily for fishing, swimming, and recreation, the State of Wisconsin criterion was used for chlorophyll *a* assessment. Chlorophyll *a* results are within the range of less than 10 $\mu\text{g/L}$ considered aesthetically pleasing for recreational and swimming uses. Chlorophyll *a* concentrations have been minimal during the duration of the baseline assessment in Crooked Lake.

9. *E. coli* Bacteria

NMCHA monitors in two locations on Crooked Lake. During the swimming season, monitoring is completed once weekly at these two sites that have beaches open to the public. There were no closures or advisories posted for the 2009 and 2010.

10. Habitat Assessment

The 2007 habitat assessment had a score of 110 and a score of 99 in 2009. According to the assessors, the water level appeared to be lower within the basin in 2009 generating a lower score than in 2007. Watershed road conditions in terms of visible erosion (and bank erosion) and runoff were more apparent in 2009 than in 2007. In 2007, purple loosestrife was identified on less than 15% of the shoreline but may have been treated by 2009 since there is not documentation of any observed then. Zebra mussels were identified during both years that habitat assessments were conducted.

11. Macroinvertebrates

2007 data identifies nine orders present throughout the sample sites in this basin. The number of orders identified had decreased until 2007. Trichopterans were not found in 2003 and 2005 but were found in 2007. The Shannon-Weiner diversity index increased as well in 2007 compared to previous years. There is a trend of the percentage of oligochaetes decreasing over time as seen in Figure 28.

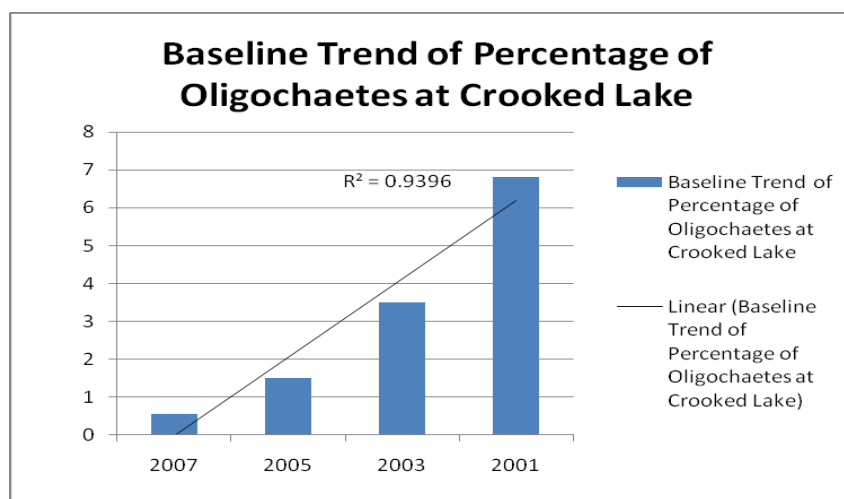


Figure 28: Baseline Trend of Percentage of Oligochaetes at Crooked Lake

Trend analysis will be completed on the 2009 macroinvertebrates after identification has been completed to confirm whether or not this trend is continuing.

E. Conclusion and/or Recommendations

The LTBB WQS has been approached by the lake association, Pickerel-Crooked Lake Association (PCLA), about monitoring both basins. The WQS will follow up with PCLA to discuss whether or not there are water quality concerns in the east basin. If there are concerns with water quality on the east basin, monitoring would be implemented in the future to assess whether or not these concerns or issues are valid.

PCLA and lake shoreline owners have been concerned that there is increased aquatic vegetation within the west basin. Monitoring results do not indicate that there are any increased loads of nutrients in the water column affecting plant growth in Crooked Lake. However, the monitoring site is only at the deepest point in the lake and no substrate analysis has been completed to assess nutrient levels locked up in the substrate. The LTBB WQS will consider doing some nutrient sampling in the future within the littoral zone of the lake as well as some substrate nutrient analysis.

The LTBB WQS will inquire with PCLA and Tip of the Mitt Watershed Council on whether or not purple loosestrife control has been completed around the shoreline of Crooked Lake.

Crooked Lake is one of the only lakes that do not currently have the invasive vegetation Eurasian milfoil. LTBB submitted a Great Lakes Restoration Initiative Grant Proposal for installation of boat washes at the public launches at this lake. This lake would benefit from boat washing in minimizing the transport of Eurasian milfoil into Crooked Lake. Once Eurasian milfoil is in Crooked Lake it can easily spread throughout the inland waterway. Efforts will continue to prevent this invasive species from entering the inland waterway via Crooked Lake.

8. Walloon Lake

A. Description and Background

Walloon Lake is a glacier formed lake serving as the headwater to the Bear River, a 14.6 mile river flowing into Little Traverse Bay of Lake Michigan. The lake resides within two counties, Emmet and Charlevoix. There are three tributaries that flow into Walloon Lake with the majority of water input from groundwater. Walloon Lake consists of five basins with a surface area of 4,320 acres. The north arm is shallower than the west arm with the deepest depth being approximately 15 meters. The northern basin in the west arm, known as Mud Lake, is less than 5 meters deep at the deepest depth and surrounded by forested wetland. The three other basins within the west arm range in deepest depth from approximately 24 to 30 meters and are similar in physical characteristics.

When the LTBB baseline assessment was started, all five basins were monitored. In 2007, the monitoring design was reassessed to increase efficiency and funding priorities. Statistical analysis was conducted on data collected in 2000, 2002, 2004, and 2006 on the three basins with similar depths and physical characteristics. The results indicated that there was no statistical difference between data sets in these basins. In conclusion, two of the basins were eliminated from the monitoring design. The data for these two basins will not be included in the Parameter Results & Baseline Analysis section. These similar basins are connected and located in the west arm. Therefore, the middle basin (WNL3) was chosen for continued monitoring. Monitoring continues on Mud Lake (WNL5) and the north arm (WNL2).

2. Tribal Use and Management

This inland lake is one of the most popular and highly used recreational lakes within the LTBB treaty delineated reservation boundaries. The north arm (WNL2) and the deep basin in the west arm (WNL3) both have a Tribal primary use of primary contact recreational. Mud Lake's primary use is indigenous aquatic life and wildlife. Designated uses for WNL2 and WNL3 include indigenous aquatic life and wildlife and coldwater fishery. Designated uses for Mud Lake are warm water fishery and primary contact recreational.

The last MDNRE fish stocking date recorded on the fish stocking database was in May of 2008. Stocking has been suspended in recent years due to viral hemorrhagic septicemia.

LTBB NRD will be conducting a fish population survey on Walloon Lake in the next few years and will share this data with the LTBB WQS.

WNL5 is habitat to mute swans, a variety of frog species, fish, sand hill cranes, blue herons, and a bald eagle that has been observed during LTBB monitoring events in this basin. There has been an effort by the Walloon Lake Association to conserve 15 acres of waterfront wetlands and 58 acres of upland within this basin through donation efforts. They have not met their goal yet, but have received about one-third of what is needed for conservation. LTBB has provided the Walloon Lake Association with information about wildlife that has been observed during monitoring events.

One reoccurring issue reported by swimmers and recreational users on Walloon Lake is cercarial dermatitis, also known as swimmer's itch. Walloon Lake Association (WLA) has taken on the responsibility of finding control efforts to minimize exposure to cercarial dermatitis. WLA contracted with a Wildlife Nuisance Control company to hunt mergansers in the 2007 fall hunting season, increasing the amount hunted in past years within the Walloon Lake Watershed. Some recommendations to avoid swimmer's itch are to discourage feeding of waterfowl, towel dry after swimming, and avoid swimming in areas of shallow water or high populations of snails and waterfowl.

C. 2010 Tribal Use Attainment

The deep basin in the west arm (WNL3) fully supports all uses. The north arm (WNL2) fully supports all uses. Temperatures exceeded the optimum growth range for rainbow trout during July and August of 2010 in the north arm. However, sampling is done in the warmest part of the day and fish have the ability to take cover or move to another area for cooler temperatures. Mud Lake (WNL5) fully supported all uses.

D. Parameter Results & Baseline Analysis

All the basins in Walloon Lake except for Mud Lake mix during the spring and fall and thermally stratify for a short period in the summer. Please see Figure 29 for an illustration of the temperature profile for WNL3. The deeper basin is stratified longer than the north arm. The north arm only displays a defined thermocline in June, July and August where as WNL3 has a defined thermocline through October. See Figure 30 for an illustration of the north arm.

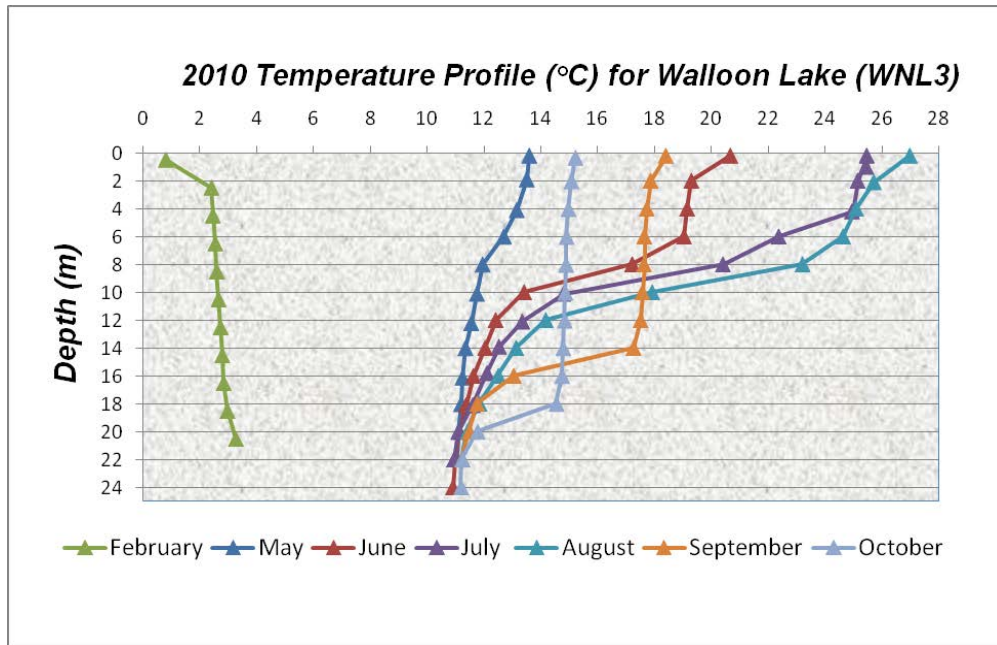


Figure 29: 2010 Temperature Profile for Walloon Lake in West Arm

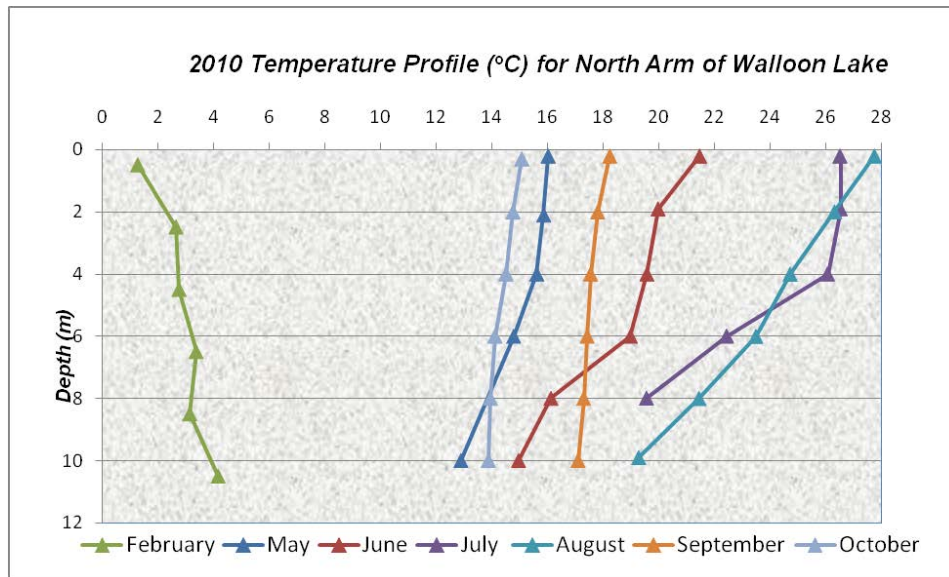


Figure 30: 2010 Temperature Profile for Walloon Lake North Arm

In the tables below, only the minimum, maximum, and median results are shown for WNL3 & WNL2 due to stratification. Chlorophyll *a* mean results will be represented in the table since it is taken only to the point in the water column where light penetrates the water.

1. Dissolved Oxygen

Table 1. Dissolved Oxygen for WNL3

2000-2010 (Even Years Only)	Results in mg/L	Date & Depth (meters)
Minimum	0.2	9/26/06 & 24.5
Maximum	14.6	2/11/10 & 0.5
Median	9.5	

During every summer of the baseline study the hypolimnion experienced anoxic conditions due stratification.

Table 1. Dissolved Oxygen for WNL2

2000-2010 (Even Years Only)	Results in mg/L	Date & Depth (meters)
Minimum	0.14	8/30/02 & 8.7
Maximum	14.23	2/11/10 & 0.5
Median	8.91	

In 2002, 2008, and 2010, anoxic conditions were observed in the hypolimnion but not in 2004 and 2006. These years did not indicate thermal stratification and data was not taken every 2 meters in these years.

Table 1. Dissolved Oxygen for WNL5

2000-2010 (Even Years Only)	Results in mg/L	Date
Minimum	2.63	2/11/10
Maximum	13.8	7/13/10
Median	9.9	
Mean	9.9	

Dissolved oxygen data indicates that oxygen depletes during the winter months. However, fish can move to other basins during the winter season.

2. Temperature

Table 2. Temperature in °C for WNL3

2000-2010 (Even Years Only)	Results in °C	Date & Depth (meters)
Minimum	0.81	2/11/10 & 0.5
Maximum	27	8/12/10 & 0.3
Median	12.5	

The 2010 winter sampling event is the minimum temperature and the maximum dissolved concentration for WNL3. This may represent a winter algal bloom just below the ice surface.

Table 2. Temperature in °C for WNL2

2000-2010 (Even Years Only)	Results in °C	Date & Depth (meters)
Minimum	1.29	2/11/10 & 0.5
Maximum	27.7	8/12/10 & 0.2
Median	17.6	

The north arm also illustrates the inverse relationship between dissolved oxygen and temperature during the winter sampling event in 2010. The temperature is comparable to the other surface water temperatures in other basins of Walloon Lake.

Table 2. Temperature in °C for WNL5

2000-2010 (Even Years Only)	Results in °C	Date
Minimum	0.71	2/11/10

Maximum	27	7/13/10
Median	14.9	
Mean	15.6	

The maximum temperature is comparable to the other basins' baseline maximum temperatures. This basin had the coldest minimum temperature recorded during the 2010 winter sampling event due to its size.

3. Conductivity

Table 3. Conductivity Results for WNL3

2000-2010 (Even Years Only)	Results in $\mu\text{S}/\text{cm}$	Date & Depth (meters)
Minimum	257.8	8/26/04 & 0.4
Maximum	326.5	10/6/10 & 24
Median	291.7	

The conductivity range throughout a lake profile is usually minimal. Typically, maximum conductivity readings occur during the winter, but this was the first lake basin in the Baseline Assessment where the maximum was recorded in October.

Table 3. Conductivity Results for WNL2

2000-2010 (Even Years Only)	Results in $\mu\text{S}/\text{cm}$	Date & Depth (meters)
Minimum	268.2	6/28/02 & 0.5
Maximum	380.6	2/11/10 & 10.5
Median	320.2	

Conductivity results are higher than in the deeper basin of the west arm however, not high enough to indicate any issues. The maximum conductivity follows the pattern of other lakes recorded having increased conductivity during the winter season.

Table 3. Conductivity results for WNL5

2000-2010 (Even Years Only)	Results in $\mu\text{S}/\text{cm}$	Date
Minimum	243.9	8/26/04
Maximum	439.8	2/11/10
Median	282.8	
Mean	266.6	

The maximum conductivity is within the winter season and the conductivity range is the largest in this basin. This is may be caused by the larger size and deeper depth, which allows for more suspended ionic particles in the water column.

4. Chloride

Table 4. Chloride results for WNL3

2000-2010 (Even Years Only)	Results in mg/L	Date & Depth
Minimum	7.4	8/30/02 & 0.5
Maximum	13.87	8/12/10 & 0.2
Median	10.36	

Table 4. Chloride results for WNL2

2000-2010 (Even Years Only)	Results in mg/L	Date & Depth
Minimum	9	5/42/04 & 4.6

Maximum	20	7/14/04 & 0.2
Median	13	

Baseline chloride levels are low and within a range suitable for all uses for both WNL3 and WNL2. The range at WNL2 is broader than at WNL3. The majority of the north arm's shoreline land use is seasonal and residential homes. The north basin has a smaller and shallower surface area than WNL3. The land use and smaller amount of water may contribute to the broader range.

Table 3. Chloride results for WNL5

2000-2010 (Even Years Only)	Results in mg/L	Date
Minimum	10	6/15/04
Maximum	24.4	2/11/10
Median	12.88	
Mean	13.6	

Baseline chloride levels are within the range suitable for all uses. Mud Lake has the broadest range due to its smaller size and volume. The maximum chloride reading (24.4) is still considered low.

5. pH

Table 5. pH results for WNL3

2000-2010 (Even Years Only)	Results in mg/L	Date & Depth (meters)
Minimum	7.28	8/30/02 & 21
Maximum	9.3	5/24/06 & 0.5
Median	8.26	

Table 5. pH results for WNL2

2000-2010 (Even Years Only)	Results in mg/L	Date & Depth (meters)
Minimum	7.35	8/30/02 & 8.7
Maximum	9.36	5/24/06 & 0.9
Median	8.3	

Table 5. pH results for WNL5

2000-2010 (Even Years Only)	pH Results	Date
Minimum	7.97	10/24/02
Maximum	9.35	5/24/06
Median	8.37	
Mean	7.75	

The maximum pH results for the basins monitored in Walloon Lake are above the range of 6.5 -9 recommended by the State of Michigan to be supported for Tribal uses in this assessment. However, ranges in Walloon Lake tend to be higher due to limestone deposits and the median results are within the suggested pH range. There was only one month that the pH results were outside the recommended range and is not considered an exceedence by LTBB due to Walloon Lake's glacial formation geology.

6. Total Phosphorus

Table 6. Total Phosphorus Results for WNL3

2000-2010 (Even Years Only)	Results in µg/L	Date & Depth (meters)
Minimum	1.3	8/30/02 & 0.5
Maximum	41.5	8/22/06 & 21.6
Median	3.9	

The baseline results of phosphorus are within the range found in unpolluted waters. The maximum total phosphorus concentration was taken at the deepest depth during anoxic conditions, which may have been the result of a release of phosphorus from the sediment.

Table 6. Total Phosphorus Results for WNL2

2000-2010 (Even Years Only)	Results in µg/L	Date & Depth (meters)
Minimum	0.5	5/18/08 & 10
Maximum	18	6/15/04 & 12.1
Median	4.75	

The baseline results are within the suggested range found in unpolluted waters.

Table 6. Total Phosphorus results for WNL5

2000-2010 (Even Years Only)	Results in µg/L	Date
Minimum	3.1	7/13/10
Maximum	58.2	5/24/06
Median	8.7	
Mean	9.79	

The maximum baseline reading exceeds what would be found in unpolluted waters. There is not a clear conclusion for this high total phosphorus reading. All other parameters are within ranges found during the spring and under normal conditions. It is the only data point for total phosphorus within the baseline data set above 15 µg/L; therefore it does not suggest prolonged water quality perturbation.

7. Total Nitrogen

Table 7. Total Nitrogen Results for WNL3

2000-2010 (Even Years Only)	Results in mg/L	Date & Depth (meters)
Minimum	0.16	9/15/10 & 10
Maximum	1.23	10/13/04 & 21.8
Median	0.41	

Table 7. Total Nitrogen Results for WNL2

2000-2010 (Even Years Only)	Results in Mg/L	Date & Depth (meters)
Minimum	0.18	10/13/04 & 0.7
Maximum	0.83	5/15/08 & 0.2
Median	0.48	

Table 7. Total Nitrogen results for WNL5

2000-2010 (Even Years Only)	Results in mg/L	Date
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Minimum	0.17	10/13/04
Maximum	1.24	8/26/04
Median	0.64	
Mean	0.65	

All baseline results for total nitrogen are within the suggested range found in unpolluted waters.

8. Chlorophyll *a*

Table 8. Chlorophyll *a* Results for WNL3

2000-2010 (Even Years Only)	Results in µg/L	Date
Minimum	0.15	5/28/02
Maximum	1.42	9/26/06
Median	0.51	
Mean	0.65	

Table 8. Chlorophyll *a* Results for WNL2

2000-2010 (Even Years Only)	Results in µg/L	Date
Minimum	0.2	10/24/02
Maximum	2.38	8/26/04
Median	0.66	
Mean	0.94	

Table 8. Chlorophyll *a* Results for WNL5

2000-2010 (Even Years Only)	Results in µg/L	Date
Minimum	0.2	10/24/02
Maximum	5.16	6/11/08
Median	1.18	
Mean	1.64	

All basins are within the less than 10 µg/L to be aesthetically pleasing and indicate few or no algal blooms during monitoring events.

9. *E. coli* Bacteria

NMCHA tests for *E. coli* on the north arm and the west arm at the two public beaches. Monitoring is done during the summer swimming season one time per week. There were no closures indicated for 2010. There have been beach closures in the past ten years but occurrences are minimal.

10. Habitat Assessment

The habitat assessment used is not an optimal choice for large developed lakes where recreation is the primary use. Therefore, a habitat assessment was not conducted in 2010 on Walloon Lake. Fishing on this lake is a popular recreational activity. Fish found in Walloon Lake consist of but are not limited to: brown, rainbow, and lake trout, smallmouth and rock bass, bluegill, perch, and walleye. As mentioned in the Tribal use/management section aquatic life and wildlife have been observed on Walloon Lake, especially in the Mud Lake Basin. Waterfowl, especially geese are observed in all basins. Sediment compositions in the deeper depths of the lake are primarily clay and

marl while the littoral zones are diverse. Littoral zone sedimentation varies from organic matter, highly vegetated, sand, and silt/fine sediment. A majority of Walloon Lake's land use is privately owned and does not have optimal vegetative cover. Public launch roads increase road runoff. This lake is also host to a variety of invasive species. Identified invasives include: *Cladophora*, Eurasian milfoil, rusty crayfish, purple loosestrife, and zebra mussels. Walloon Lake Association has also shown interest in boat washing stations as a technology to minimize the transport of invasive species into and out of this waterbody.

11. Macroinvertebrates

Macroinvertebrate data at Walloon Lake is collected in the southwest basin in the west arm with one site located in the basin just north of the southwest basin on the west side. Although other changes have occurred in the water sampling methodologies of the surface water quality monitoring program, the macroinvertebrate study has not been updated. These sites were chosen in 2000, and in order to collect comparable long term baseline data, other basins have not been added. The nonexistence of macroinvertebrate collection in other basins where other parameters are monitored is considered a data gap especially in Mud Lake where aquatic life may depend on macroinvertebrates for food. New sites may be chosen in Mud Lake and the north arm in a future workplan.

Macroinvertebrate data for 2008 is currently unavailable. Discussion of these results will be discussed in the submission of the next water quality assessment report.

E. Conclusion and/or Recommendations

Walloon Lake Association (WLA) has a long-term volunteer monitoring program. The WQS has met with the lead contact of that program and has discussed meeting later to discuss the needs, concerns, and efficiency of monitoring on Walloon Lake. Since WLA monitors as well, the Tribe will reduce monitoring on Walloon Lake to a frequency of every three years to increase time and efficiency without compromising data collection. If there are areas or parameters that are not being monitored that WLA and the Tribe feel are necessary, the WQS may change the parameter design as well.

Due to Walloon Lake's popularity for fishing and recreation, invasive species management and control is of high priority for Walloon Lake. Pursuance of control and management to protect the quality of the water for these uses will continue along with collaboration with lake stakeholders and the Tribe.

9. Lake Charlevoix

A. Description and Background

Lake Charlevoix has two basins and is connected to Lake Michigan. It is the third largest lake in Michigan with a surface area of 17,264 acres. Lake Charlevoix flows into Round Lake (this is not the Round Lake connected to the Inland waterway and assessed by LTBB) into the Pine River and drains into Lake Michigan. Lake Charlevoix has nine tributaries that flow into it. 75% of the discharge into Lake Charlevoix is contributed to the Jordan River and the Boyne River. The deepest point in Lake Charlevoix is located in the main basin at approximately 37 meters. The Lake Charlevoix watershed encompasses over 335 square miles. Three main cities border the lake. These cities are Charlevoix, located on the northwest corner of the north arm, Boyne City in the northeast corner of the north arm, and East Jordan in the south arm.

The majority of land cover surrounding the Lake Charlevoix shoreline is urban and built up for seasonal residential housing. Impacts on the Lake Charlevoix Watershed can be traced back to the 1800's when lumbering industries bordered the Lake Charlevoix shoreline. Potential impacts of the

present time include but are not limited to: discharge for treated wastewater from Boyne City into the main basin, residential shoreline nutrient runoff and sediment runoff at road accesses and on shorelines.

The Tribe has two monitoring sites on Lake Charlevoix, one per basin. The monitoring site on the south arm (CXL1) has a depth of 11 meters. The monitoring site on the main basin (CXL2) is at a depth of approximately 30 meters.

B. Tribal Use and Management

The main basin and the south arm have draft primary uses of primary contact recreational. Recreational boating, swimming, water sports, and fishing are the dominant uses in Lake Charlevoix. According to the MDNRE fish stocking website, Lake Charlevoix was last stocked with 21,146 lake trout at two sites in April of 2008. LTBB draft designated uses include: cold water and subsistence fishery, indigenous aquatic life and wildlife, cultural/ceremonial, and navigation. Results of the Tribal uses questionnaire given at the 2008 LTBB community meeting indicated that Lake Charlevoix was the third most used lake by Tribal citizens. Lake Charlevoix Tribal uses include swimming, fishing, boating, and ceremonial/cultural uses.

LTBB is a project partner of the EPA approved Lake Charlevoix Watershed Management Plan. The management plan is available at <http://www.watershedcouncil.org/protect/watershed%20management/files/Lake%20Charlevoix%20Watershed%20Project.pdf>. Some of the management goals in the plan will be addressed by the EPA 319 funds for Non-Point Source Pollution, received by Tip of the Mitt Watershed Council. LTBB has collaborated by supplying baseline data to Tip of the Mitt Watershed staff who are tasked with completing activities in the 319 plan.

LTBB has submitted their past water quality assessment reports to the Lake Charlevoix Association, presented water quality presentations, and participates in functions that support the Lake Charlevoix watershed's management goals. LTBB is an active member of the Lake Charlevoix Steering Committee as well. LTBB will continue to work collaboratively with other organizations and local governments that share similar goals pertaining to water quality.

C. 2009 Tribal Use Attainment

All uses are fully supported on both basins except for the subsistence fishery use. The south arm had temperatures higher than the recommended 19° C for rainbow trout growth during the month of September. However, this is not a concern since fish have the ability to seek cover, or move to the main basin, tributaries, or Lake Michigan. Lake Charlevoix is listed on the MDNRE's 303d impairment list because of PCBs in fish tissue. LTBB does not do fish tissue sampling currently and cannot confirm whether or not the number of fish caught by Tribal citizens would cause health impacts based on MDNRE's assessment. Therefore, use attainment for subsistence fishery has been assessed as only partially supported. LTBB will pursue fish tissue research in the future.

D. Parameter Results & Baseline Analysis

In 2009, the main basin and the south arm mixed during the spring and fall and thermally stratified during the summer. The south arm does not always stratify. Please see Figure 31 for an illustration of the temperature profile for the south arm (CXL1). The south arm stratifies later than the main basin and mixes sooner than the main basin, due to size and depth differences between the two basins. See Figure 32 for the temperature profiles of the main basin.

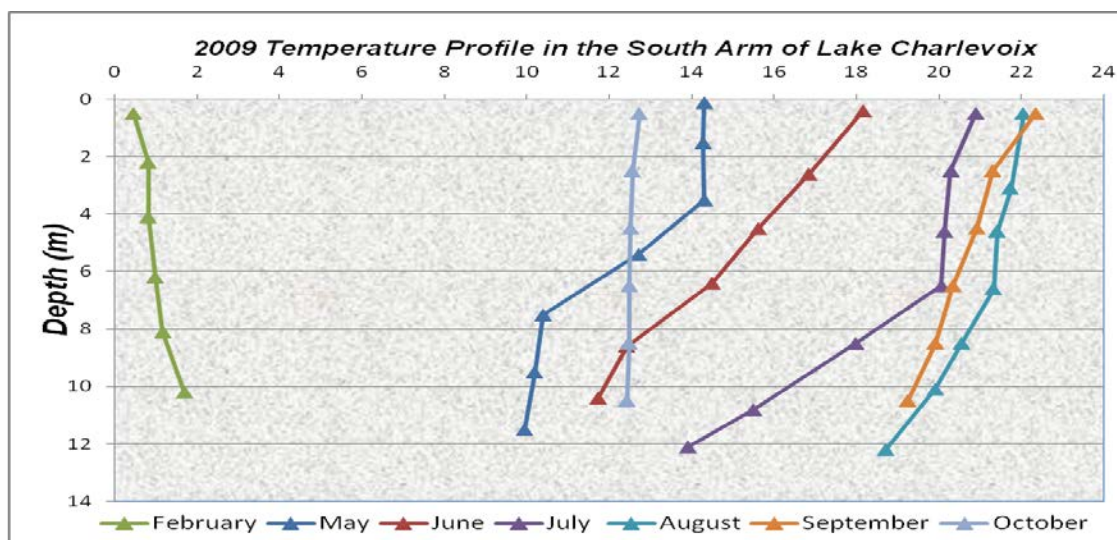


Figure 31: 2009 Temperature Profile in the south arm of Lake Charlevoix

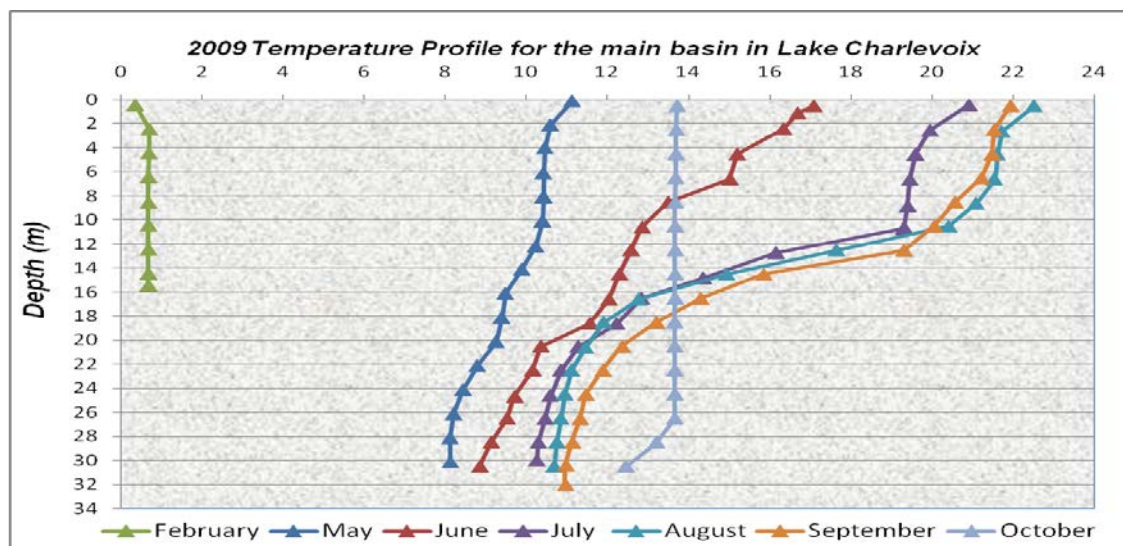


Figure 32: 2009 Temperature Profile for the main basin in Lake Charlevoix

In the following tables, only the minimum, maximum, and median parameter results will be shown for the two basins since it is a stratified lake. Chlorophyll *a* mean results will be represented in the table since it is taken only to the point in the water column where light penetrates the water.

1. Dissolved Oxygen

Table 1. Dissolved Oxygen for CXL1

2001-2009 (Odd Years Only)	Results in mg/L	Date & Depth (meters)
Minimum	3.16	8/23/05 & 11.5
Maximum	14.08	6/22/05 & 11.5
Median	9.88	

Baseline dissolved oxygen ranges were wide. The minimum reading was recorded in the hypolimnion during stratification and concentrations were above 5 mg/L in the epilimnion during this period. Therefore, coldwater fish were supported based on the State of Michigan rules for lakes that stratify.

Table 1. Dissolved Oxygen for CXL2

2001-2009 (Odd Years Only)	Results in mg/L	Date & Depth (meters)
Minimum	7.21	10/9/03 & 32.6
Maximum	14.3	3/17/09 & 0.4
Median	10.1	

Dissolved oxygen concentrations were fully supportive in each water column layer in the main basin.

2. Temperature

Table 2. Temperature in °C for CXL1

2001-2009 (Odd Years Only)	Results in °C	Date & Depth (meters)
Minimum	0.45	3/17/09 & 0.5
Maximum	23.76	8/26/03 & 0.2
Median	15.76	

Table 2. Temperature in °C for CXL2

2001-2009 (Odd Years Only)	Results in °C	Date & Depth (meters)
Minimum	0.36	3/17/09 & 0.4
Maximum	24.31	7/25/01 & 2.7
Median	12.35	

The winter sampling event depicts the inverse relationship of temperature and dissolved oxygen at CXL1. The dissolved oxygen concentration is just over 100% saturation. Although, both baseline maximum temperatures exceed the suggested optimum growth threshold for rainbow trout, fish have the ability to go to deeper water, tributaries, and Lake Michigan.

3. Conductivity

Table 3. Conductivity Results for CXL1

2001-2009 (Odd Years Only)	Results in $\mu\text{S/cm}$	Date & Depth (meters)
Minimum	303.5	5/8/01 & 12.9
Maximum	369.9	3/17/09 & 10.2
Median	336.7	

The baseline range and the conductivity range throughout a lake profile during a sampling event are minimal. This was the first lake basin that the results did not indicate the maximum conductivity reading taking place during a winter sampling event.

Table 3. Conductivity Results for CXL2

2001-2009 (Odd Years Only)	Results in $\mu\text{S/cm}$	Date & Depth (meters)
Minimum	308.7	9/45/07 & 6

Maximum	350.5	9/21/05 & 29.6
Median	329.6	

The baseline conductivity range in the main basin and south arm are comparable. Conductivity readings are within the range results seen in other deep lakes that stratify.

4. Chloride

Table 4. Chloride results for CXL1

2001-2009 (Odd Years Only)	Results in mg/L	Date & Depth
Minimum	4.4	5/23/03 & 10.6
Maximum	11.7	5/23/03 & 0.5
Median	8.74	

Table 4. Chloride results for CXL2

2001-2009 (Odd Years Only)	Results in mg/L	Date & Depth
Minimum	0.24	5/8/01 & 16.8
Maximum	13.47	9/5/07 & 6
Median	10.1	

The baseline range for chloride is low in the main basin and the south arm. Baseline chloride concentrations support all Tribal uses.

5. pH

Table 5. pH results for CXL1

2001-2009 (Odd Years Only)	pH Results	Date & Depth (meters)
Minimum	7.35	8/23/2005 & 11.5
Maximum	8.5	5/28/2009 & .1, 1.5
Median	8.29	

Table 5. pH results for CXL2

2001-2009 (Odd Years Only)	pH Results	Date & Depth (meters)
Minimum	7.47	10/14/2009 & .5
Maximum	8.51	8/12/2009 & 4.5
Median	8.22	

The baseline results are within the recommended range of 6.5- 9 used for Tribal use attainment.

6. Total Phosphorus

Table 6. Total Phosphorus Results for CXL1

2001-2009 (Odd Years Only)	Results in µg/L	Date & Depth (meters)
Minimum	0.6	9/9/2009 & 0.5
Maximum	12.3	9/21/2005 & 5.5
Median	3.7	

Table 6. Total Phosphorus results for CXL2

2001-2009 (Odd Years Only)	Results in µg/L	Date
Minimum	0.5	9/9/2009 & 32
Maximum	12.3	6/22/2005 & 30.5

Median	2.65	
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Baseline total phosphorus results for the main basin and south arm are within the range found in unpolluted waters.

7. Total Nitrogen

Table 7. Total Nitrogen Results for CXL1

2001-2009 (Odd Years Only)	Results in mg/L	Date & Depth (meters)
Minimum	0.35	8/23/2005 & 11.5
Maximum	1.69	5/23/2003 & 0.5
Median	0.66	

Table 7. Total Nitrogen Results for CXL2

2001-2009 (Odd Years Only)	Results in mg/L	Date & Depth (meters)
Minimum	0.27	6/13/2007 & 0.2
Maximum	1.55	5/23/2003 & 15
Median	0.58	

Baseline results for total nitrogen are within the range suggested to be found in unpolluted waters.

8. Chlorophyll *a*

Table 8. Chlorophyll *a* Results for CXL1

2001-2009 (Odd Years Only)	Results in µg/L	Date
Minimum	0.2	7/23/2003 & 0.5
Maximum	2.14	5/8/2001 & 2.6
Median	0.71	
Mean	0.84	

Table 8. Chlorophyll *a* Results for CXL2

2001-2009 (Odd Years Only)	Results in µg/L	Date
Minimum	0.2	7/23/2003 & 0.6
Maximum	1.86	5/8/2001 & 3.3
Median	0.53	
Mean	0.62	

Baseline results for Chlorophyll *a* are less than 10 µg/L, the recommended value used for lakes with a predominate use of recreation, swimming, and water sports.

9. *E. coli* Bacteria

NMCHA test for *E. coli* bacteria at twelve beaches around Lake Charlevoix. In 2010, NMCHA monitored once a week during the swimming summer season. No beach closure advisories were reported at any of the beaches monitored in 2010.

10. Habitat Assessment

The habitat assessment used by the WQS is not suitable for larger lakes with predominate land use of recreation and land cover of residential and/or seasonal residential. Therefore, there

was not a habitat assessment conducted in 2009. Increasing population of existing invasive species and new invasive species are a concern for Lake Charlevoix stakeholders. Invasive aquatic vegetation and species that currently have been identified in Lake Charlevoix are: Eurasian milfoil, rusty crayfish, and zebra and quagga mussels. *Cladophora* has been identified by Tip of the Mitt Watershed Council on the Lake Charlevoix shoreline as well as suitable shoreline habitat conditions for the alga's growth.

11. Macroinvertebrates

2007 macroinvertebrate results do not indicate any baseline trends other than for the percentage of oligochaetes. Oligochaetes have decreased over time ($R^2=0.99$). Please see Figure 33.

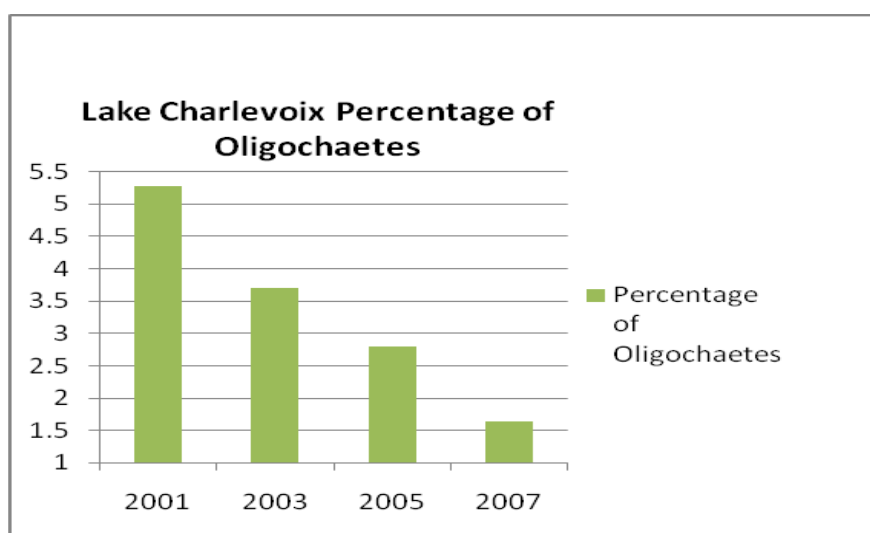


Figure 33: Lake Charlevoix Percentage of Oligochaetes

The dominant taxon percentage decreased and the diversity score increased until 2007, Percentage of Ephemeroptera, Plecoptera, and Trichoptera decreased through 2003 and 2005, but increased in 2007. Based on these results, water quality trends cannot be solely based on macroinvertebrate metrics.

E. Conclusion and/or Recommendations

Based on the baseline results, the Tribe will change the frequency of sampling on Lake Charlevoix to every three years. Lake Charlevoix Association has addressed concerns and issues through its Lake Charlevoix Management Plan and now has implementation funds through an EPA 319 Non-point Source Proposal submitted by Tip of the Mitt Watershed Council. LTBB will continue to participate on the Lake Charlevoix Watershed and Steering Committee and will continue to collaborate on shared goals.

10. Little Traverse Bay

A. Description and Background

Little Traverse Bay is the fourth largest bay of Lake Michigan. Little Traverse Bay Watershed includes Bay Harbor Lake (a flooded quarry adjacent to Lake Michigan), Bear River, Hay Marsh Creek, Spring Brook, Tannery Creek, and Five Mile Creek. Cities surrounding Little Traverse Bay include Charlevoix, Petoskey, and Harbor Springs.

LTBB citizens have been dependent on the bay historically and presently. Historically, the bay was used for agriculture, potable water, transportation, hunting, ceremonial/cultural use, trapping, and fishing purposes. According to the Tribal uses questionnaire given to Tribal citizens at the 2008 Tribal community meeting, Little Traverse Bay is the most used lake by Tribal citizens monitored by LTBB Surface Water Quality Monitoring Program. Recreation, fishing, and ceremonial/cultural were uses identified by Tribal citizens. The bay has served as a site for many cultural/ceremonial uses, such as the Annual Jiimaan crossing and traditional weddings. The shoreline of Little Traverse Bay was a common burial ground for Odawa People who have passed.

The surface area of the bay is 29,973 acres. There are two monitoring sites within the bay. LTB1 is located just north of the Petoskey waterfront at an average depth of 34 meters. LTB2 is located west of the Petoskey State Park at an average depth of 32 meters.

B. Tribal Use and Management

Little Traverse Bay's Tribal primary use is primary contact recreational. Designated uses include: cold water and subsistence fishery, indigenous aquatic life and wildlife, cultural/ceremonial, and public water supply. The city of Charlevoix uses the bay as their primary source of potable water.

According to the MDNRE fish stocking database, Little Traverse Bay was last stocked March 31st, 2009 with 19,600 brown trout. Other fish found in Little Traverse Bay include but are not limited to: salmon, rainbow trout, whitefish, lake trout, bass and perch.

LTBB ESP has worked collaboratively with Tip of the Mitt Watershed Council and all other partners in creating a Little Traverse Bay Watershed Protection Plan. LTBB NRD Environmental Services Staff have been active participants in the Little Traverse Bay Watershed Workgroup. In this plan there are nonpoint source pollution inventories, priority pollutants and best management practices, goals, objectives, and recommended actions. A copy of the plan is available at <http://www.freshwatercenter.org/ltbodyplan.pdf>.

C. 2010 Tribal Use Attainment

All uses are supported except for a subsistence fishery. Although Little Traverse Bay could not be found on the 303d list, it is assumed that fish contain levels of mercury and PCBs. Therefore, partial support is given to subsistence fishery. Temperatures were below 19 °C at least in the hypolimnion during all monitoring events, except in September at LTB1 in 2002 and 2010. Temperatures at or below 19 °C are optimum for rainbow trout growth. These September exceedences are not of concern since LTB2's entire water column was below 19 °C at the same time allowing fish to move to colder areas throughout the bay.

D. Parameter Results and Baseline Analysis

In 2010, both sites had uniform water columns in terms of temperature in May and July. A defined thermocline can be graphed during June, August, and September. At both monitoring locations it appears that temperatures return to uniformity in July. This may be due to mild

temperatures and strong winds mixing the water column during that month. Please see Figures 34 and 35.

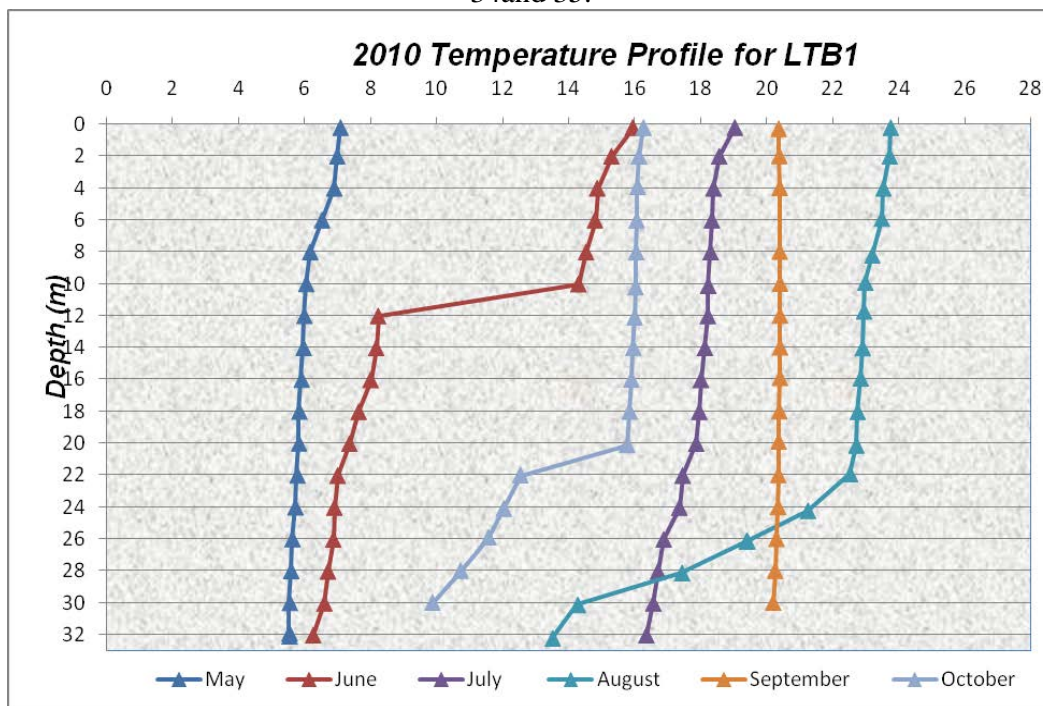


Figure 34: 2010 Temperature Profile for LTB1

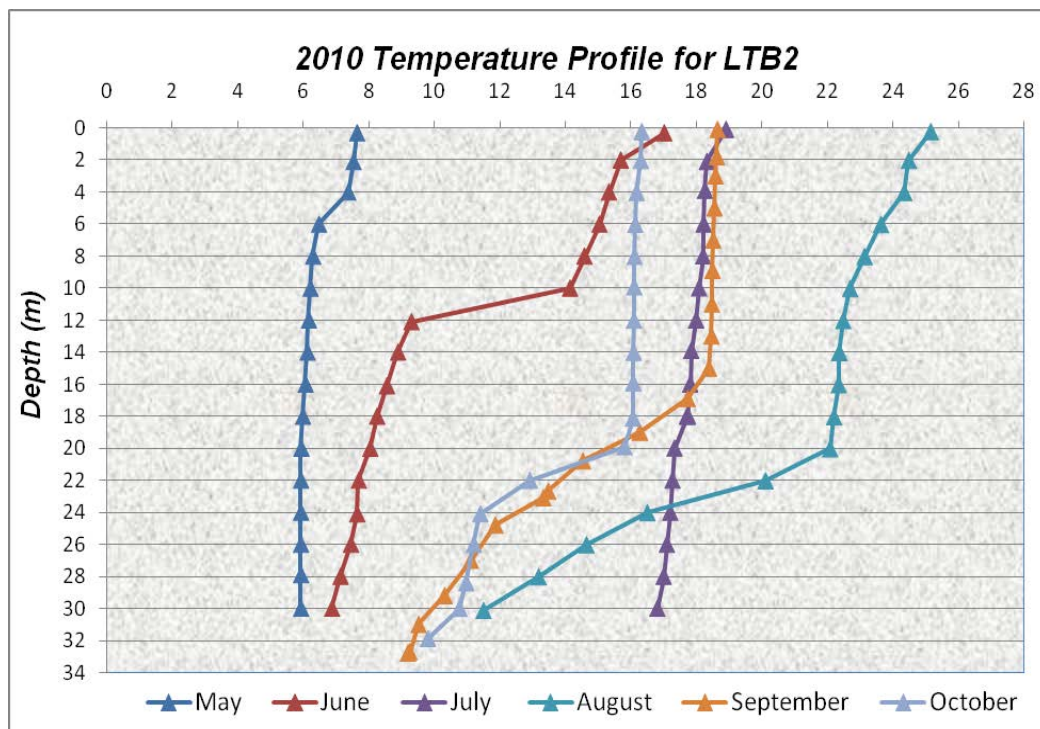


Figure 35: 2010 Temperature Profile for LTB2

In the following tables, only the minimum, maximum, and median parameter results are shown for the two monitoring sites since it is a stratified lake. Chlorophyll *a* mean results will be represented in the table since it is taken only to the point in the water column where light penetrates the water.

1. Dissolved Oxygen

Table 1. Dissolved Oxygen for LTB1

2000-2010 (Even Years Only)	Results in mg/L	Date & Depth (meters)
Minimum	7.67	9/9/2002 & 28.4
Maximum	14.57	6/8/10 & 32
Median	10.31	

Table 1. Dissolved Oxygen for LTB2

2000-2010 (Even Years Only)	Results in mg/L	Date & Depth (meters)
Minimum	6.87	10/30/2000 & 2.6
Maximum	14.77	6/8/10 & 30
Median	10.11	

Baseline dissolved oxygen concentrations were always above the State of Michigan recommended threshold criteria of 7 mg/L at LTB1. LTB2's minimum concentration (6.87) was reported at the surface while readings taken mid-depth and near the bottom were above 7 mg/L.

2. Temperature

Table 2. Temperature in °C for LTB1

2000-2010 (Even Years Only)	Results in °C	Date & Depth (meters)
Minimum	3.83	5/11/2004 & 14.3
Maximum	23.75	8/10/2010 & 0.2
Median	14.46	

Table 2. Temperature in °C for LTB2

2000-2010 (Even Years Only)	Results in °C	Date & Depth (meters)
Minimum	3.53	5/11/2004 & 16.6
Maximum	25.14	8/13/2010 & 0.2
Median	14.58	

The maximum temperatures have exceeded the suggested optimum growth threshold of 19° C in the surface waters of each site. Temperatures exceeded throughout the water column at LTB1 in September of 2002 and 2010 and in August of 2006. Since fish can move to other areas in the bay and the temperature exceedence was probably only for short period of time it is not a concern for fish survival or growth.

3. Conductivity

Table 3. Conductivity Results for LTB1

2000-2010 (Even Years Only)	Results in µS/cm	Date & Depth (meters)
Minimum	9.87	7/8/2004 & 0.9
Maximum	304.6	8/11/2008 & 4. 2
Median	288.6	

Table 3. Conductivity Results for LTB2

2000-2010 (Even Years Only)	Results in $\mu\text{S}/\text{cm}$	Date & Depth (meters)
Minimum	248.7	5/11/2004 & 0.3
Maximum	304.8	8/11/2008 & 0.1
Median	286	

The baseline conductivity range is narrow at LTB2. LTB1's range is wide with the minimum conductivity reading being 9.87 and the maximum reading being 304.6. The waters have deep water clarity and nutrient and chemical parameter results are low. Overall, the majority of conductivity readings are comparable to other stratified lakes monitored in the program.

4. Chloride

Table 4. Chloride results for LTB1

2000-2010 (Even Years Only)	Results in mg/L	Date & Depth
Minimum	7.5	6/25/2002 & 14.4
Maximum	17.4	7/10/2008 & 0.1
Median	11.4	

Table 4. Chloride results for LTB2

2000-2010 (Even Years Only)	Results in mg/L	Date & Depth
Minimum	3.2	10/12/2004 & 37.5
Maximum	18.82	7/10/2008 & 32
Median	11.24	

Baseline chloride results fully support all Tribal use at both monitoring sites.

5. Ph

Table 5. pH results for LTB1

2000-2010 (Even Years Only)	pH Results	Date & Depth (meters)
Minimum	7.65	8/11/2008 & 34.1
Maximum	8.81	10/5/2010 & 8
Median	8.27	

Table 5. pH results for LTB2

2000-2010 (Even Years Only)	pH Results	Date & Depth (meters)
Minimum	7.22	8/8/2001 & 34
Maximum	9.14	10/20/2000 & 2.6
Median	8.3	

All pH results at LTB1 were within the State of Michigan's suggested range and LTB2 only had one exceedence above 9 pH units during the baseline assessment. LTB1 and LTB2 median results within the suggest range. Results for pH will be more basic due to the limestone bedrock and geology of the bay.

6. Total Phosphorus

Table 6. Total Phosphorus Results for LTB1

2000-2010 (Even Years Only)	Results in µg/L	Date & Depth (meters)
Minimum	0.5	10/7/2008 & 18
Maximum	12.5	10/2/2006 & 34.2
Median	3.6	

Table 6. Total Phosphorus results for LTB2

2000-2010 (Even Years Only)	Results in µg/L	Date
Minimum	1.2	7/31/2002 & 14.2
Maximum	9.1	7/31/2002 & 28.9
Median	3.4	

The baseline results are within the suggested range found in unpolluted waters.

7. Total Nitrogen

Table 7. Total Nitrogen Results for LTB1

2000-2010 (Even Years Only)	Results in mg/L	Date & Depth (meters)
Minimum	0.289	6/2/2008 & 32
Maximum	5	9/10/2008 & 16
Median		

Table 7. Total Nitrogen Results for LTB2

2000-2010 (Even Years Only)	Results in mg/L	Date & Depth (meters)
Minimum	0.23	9/10/2008 & 16.1
Maximum	7.73	9/9/2002 & 27.9
Median	0.5	

Baseline results for total nitrogen are within the range suggested to be found in unpolluted waters at LTB1. The maximum result for LTB2 was predominately composed of Total Kjeldahl Nitrogen (7.5 mg/L). This result is an outlier and upon investigation the reason for the increase is unknown. Since it is the only occurrence above 5 mg/L, no action is needed and it is not a concern to future water quality.

8. Chlorophyll *a*

Table 8. Chlorophyll *a* Results for LTB1

2000-2010 (Even Years Only)	Results in µg/L	Date
Minimum	0.21	6/8/10 & 16
Maximum	1.82	8/23/2002 & 0.6
Median	0.64	
Mean	0.75	

Table 8. Chlorophyll *a* Results for LTB2

2000-2010 (Even Years Only)	Results in µg/L	Date
Minimum	0.11	9/8/2004 & 0.8
Maximum	3.6	7/8/2004 & 0.2

Median	0.72	
Mean	0.85	

Baseline results for chlorophyll *a* are less than 10 µg/L, the recommended value used for lakes with a predominate use of recreation, swimming, and water sports.

9. *E. coli* Bacteria

NMCHA monitors at all recognized public swimming beaches on the bay in Emmet and Charlevoix County. In 2010, their schedule was once a week during the swimming season. No beach closures were issued in 2010 for high *E. coli* bacteria counts.

10. Habitat Assessment

The habitat assessment used by the WQS is not suitable for larger lakes with predominate land use of recreation and land cover of residential and/or seasonal residential. Therefore, there was not a habitat assessment conducted in 2010 on the bay. Habitat issues are invasive species and a discharge permit for treated water from draining leachate from an existing cement factory in Bay Harbor. Invasive species reported in the bay are: curly-leaf pondweed, Eurasian milfoil, *Cladophora*, round goby and the rusty crayfish.

The LTBB Environmental Services Coordinator and the Great Lakes Fisheries Biologist were active in the Bay Harbor Stakeholder's Group during discussions and negotiations of what is the best treatment and disposal solution for the leachate [mixture of water, mercury, cement kiln dust (CKD), arsenic, and lead].

11. Macroinvertebrates

Macroinvertebrate data for 2008 is not available at this time. Data is available for 2006, 2004, 2002, and 2000 data. 2006 and 2004 can be compared but cannot be compared to 2002 and 2000 data. 2002 and 2000 data included a site that is now within the littoral zone of the EPA designated Superfund Removal site for the CKD removal. Remediation work was being done during 2006 and 2004. In 2008, a grab sample was taken since the site was accessible. These results will be compared to 2002 and 2000 data. The number of macroinvertebrates found at the benthic sites in Little Traverse Bay has always been low in comparison with all other waterbodies. The substrate is limestone bedrock or dense limestone cobble at two of the grab sites, creating difficulty in getting a large sample. As mentioned in the Walloon Lake summary, there have not been updates on the macroinvertebrate study. However, eliminating collection at Little Traverse Bay was discussed with the LTBB Environmental Services Director. The ESD Director's decision was to continue to sample until sufficient baseline data has been gathered. Comparing 2004 to 2006 data only, the Shannon-Weiner Diversity Index score decreased from 1.84 to 1.64. There were no oligochaetes found at the Little Traverse Bay sites in either year. The dominant taxon increased from 30 to 42. The percentage of Ephemeroptera, Plecoptera, and Odonata decreased from 6.7 % to 0%. Although these results might indicate an increase in perturbation, two years of data may not be sufficient to determine this as a final conclusion.

E. Conclusion and/or Recommendations

Data collection through the LTBB water monitoring program indicates little concern for water quality issues for the parameters currently measured. However, concerns of mercury and heavy metals by the Bay Harbor discharged treated leachate may still be an issue. The LTBB water quality monitoring program will continue to monitor the bay. The next year of monitoring will be in 2012. A site near the discharge of the treated leachate will be considered as well as monitoring for heavy metals and possibly mercury. Other sites will be considered in the littoral zone of the bay as well as

monitoring at the existing baseline sites. The baseline macroinvertebrate sites will be eliminated after 2010 and new sites near the mouth of tributaries may be considered.

LTBB will continue to be actively involved in the Little Traverse Bay Watershed Workgroup and provide any assistance and collaboration for shared goals. Currently, the LTBB Environmental Services Program is a partner in a grant submitted by Tip of the Mitt Watershed Council to implement riparian stabilization and removal of impervious old structures in a tributary of Little Traverse Bay. This tributary is known as Tannery Creek, and has been classified as a tributary of high priority of concern for water quality by creek stakeholders, LTBB, and Tip of the Mitt Watershed Council. LTBB and Tip of the Mitt Watershed will continue to seek funding for Tannery Creek through various grant opportunities.

Stream, Creek, or River Narrative Summaries **(See Appendix 2 for Degree of use support)**

1. Wycamp/Spirit Creek

A. Site Description and Background

Wycamp Creek is perennial warm water fishery with principal migratory routes for anadromous salmonids. The creek originates at Spirit Lake and flows into Lake Michigan. Wycamp Creek is approximately 1.68 miles in length. Wycamp Creek's land base is owned by the State of Michigan and approximately 30 acres is within a conservation easement. The conservation easement is located at the mouth of the creek.

Prior to European settlement, Odawa people lived in the area adjacent to the mouth of Wycamp Creek where it flows into Lake Michigan (Andrews, 2006). There is still a large population of Odawa living in this area. According to the Tribal uses questionnaire, Wycamp Creek is the third most Tribally used creek. Dominant Tribal uses are cultural/ceremonial and fishing.

There are two monitoring sites on Wycamp Creek. WPC1 is located at the mouth of the creek on the conservation easement land. The cross section width of the WPC1 site is approximately 6.7 meters. The upper monitoring site on Wycamp Creek (WPC2) is located just beyond the headwaters (Wycamp Lake) on State of Michigan land and has a cross section width of approximately 6.1 meters.

B. Tribal Use and Management

The LTBB draft primary use for Wycamp Creek is a warm water fishery with principal migratory routes for anadromous salmonids. This creek is fished by Odawa people especially during salmon spawning runs utilizing traditional spears. Other draft designated uses are cultural/ceremonial, primary contact recreational, subsistence fishery, and indigenous aquatic life and wildlife.

Changes in specific water quality parameters on the creek can be dependent on the management of the dam on Wycamp Lake. In 2006, total suspended solids and increased flow readings indicated an increased amount of sedimentation in the creek bed during a spawning period. This was due to an early board removal. In 2008, the responsible party for management of the dam changed. Concerns were communicated to the new responsible party. Temperature exceedences have also been a concern for egg survival.

C. 2010 Tribal Use Attainment

Partial support is attained for primary use of warm water fishery with principal migratory routes for anadromous salmonids due to temperature exceedences for optimum spawning temperatures during spawning runs. Temperatures also exceed embryo survival and growth thresholds during summer monitoring events. It is important to note that monitoring takes place during the hottest part of the day. Both sites have a partially open canopy with constant sunlight penetration. It is still unknown if the anadromous salmonids are succeeding in reproduction in this creek. All other parameters are within recommended thresholds for the primary use as well as all other designated uses. All other designated uses are fully supported.

D. Parameter Results & Baseline Analysis

1. Dissolved Oxygen

Table 1. 2000-2010 Dissolved Oxygen Results

Wycamp Creek-Downstream (WPC1)	Results in mg/L	Date
Minimum	6.86	8/15/2000
Maximum	14.5	2/9/2010
Mean	9.17	
Median	9.18	
Wycamp Creek-Upstream (WPC2)	Results in mg/L	Date
Minimum	4.91	8/15/2000
Maximum	14.44	2/8/2010
Mean	8.44	
Median	8.11	

Baseline dissolved oxygen concentrations were above 7 mg/L during most monitoring events. WPC2 was below the suggested 7 mg/L during three monitoring events prior to 2008 and WPC1 only once in August of 2000. Yearly averages are above 7 mg/L except at WPC2 in 2000. Monitoring did not begin until August in 2000. The downstream site, WPC1 has higher yearly average dissolved oxygen concentrations than the upstream site, WPC2, except in 2010. See Figure 36.

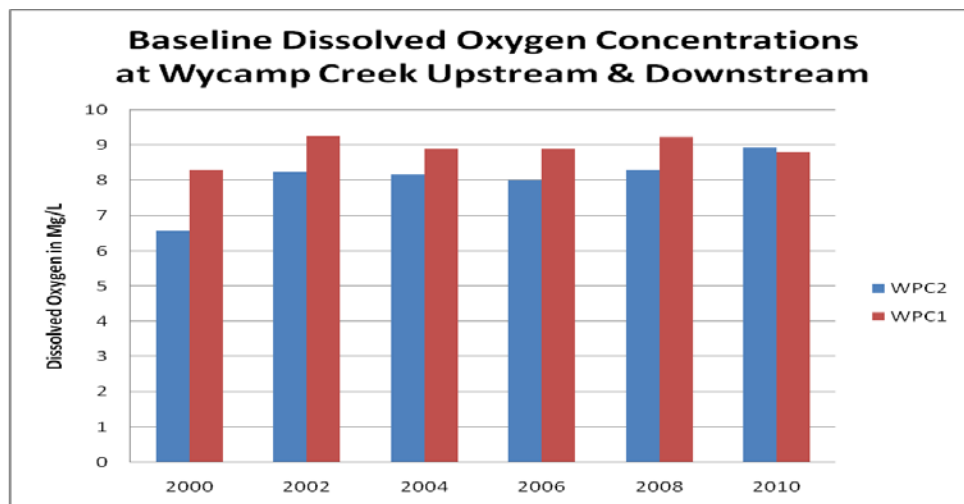


Figure 36: Baseline Dissolve Oxygen Concentrations at Wycamp Creek Upstream & Downstream

2. Temperature

Table 2. 2000-2010 Temperature Results

Wycamp Creek-Downstream (WPC1)	Results in °C	Date
Minimum	-0.14	2/15/2008
Maximum	24.37	7/9/2010
Mean	16.33	
Median	16.3	
Wycamp Creek-Upstream (WPC2)	Results in °C	Date
Minimum	1.88	2/19/2008
Maximum	26.68	7/9/2010
Mean	17.27	
Median	17.74	

Yearly average temperatures follow the same pattern as dissolved oxygen between the two sites. WPC1 had lower temperature averages than WPC2. The minimum result for WPC1 may be due to ice coverage on the temperature probe indicating a negative reading. The charts below show the optimum threshold temperatures for rainbow trout growth (black line), spawning (red line), and embryo survival (green). Fish require temperatures below the respective thresholds for their life stages. See Figures 37 and 38.

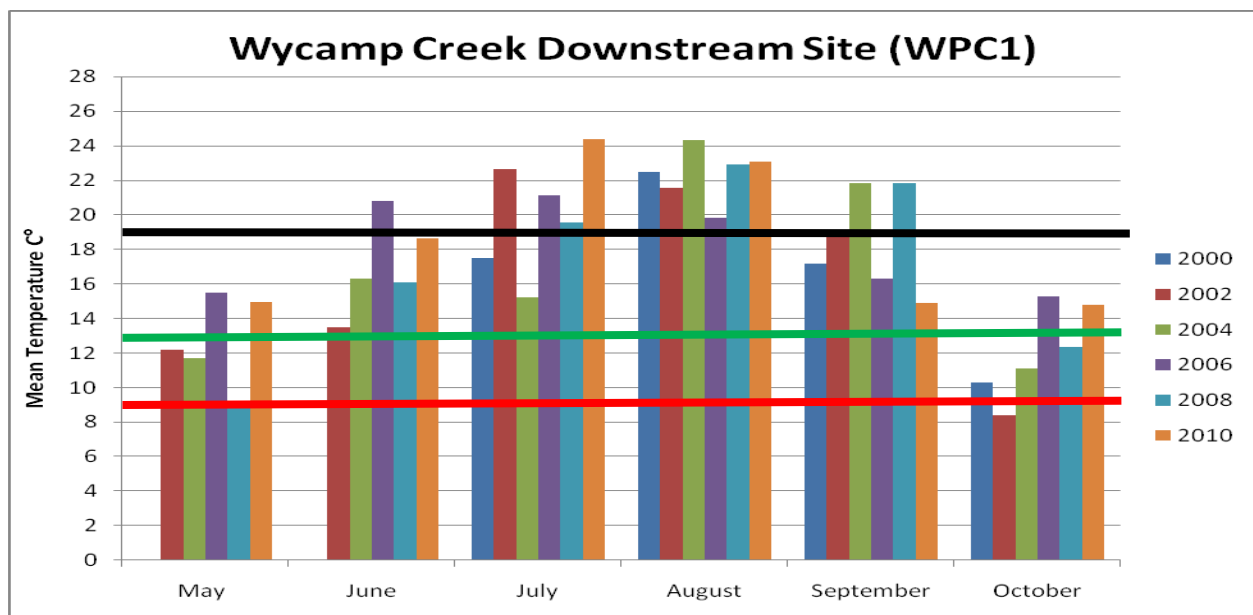


Figure 37: Wycamp Creek Downstream Site (WPC1)

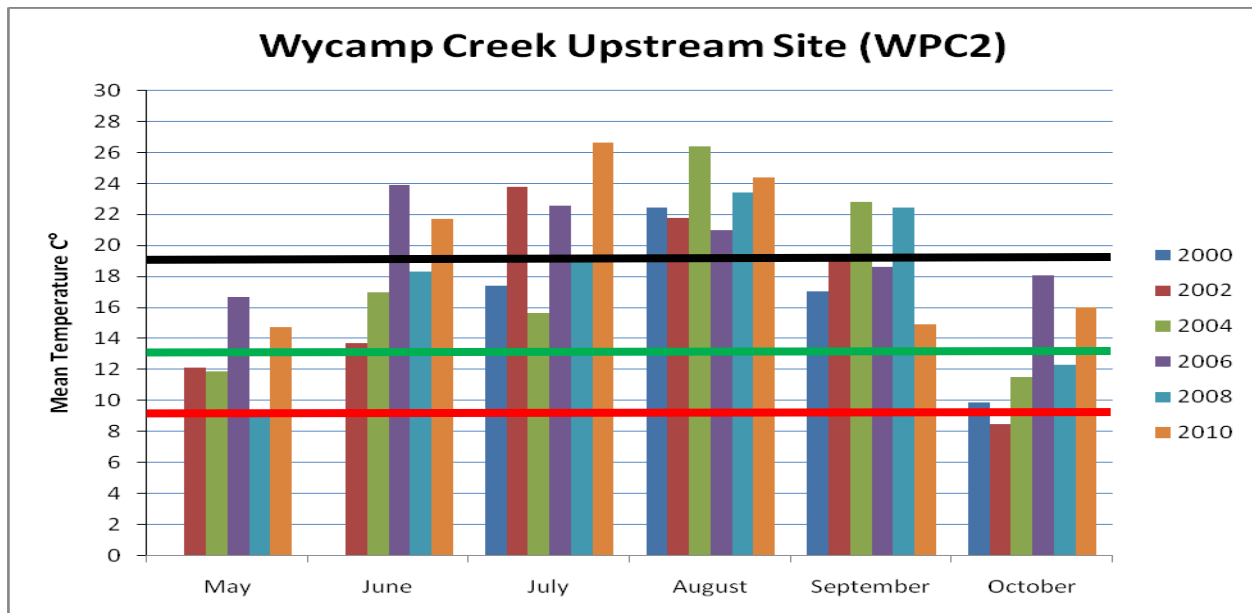


Figure 38: Wycamp Creek Upstream Site (WPC2)

Baseline temperatures in the creek exceed optimum thresholds a majority of the time for growth, spawning periods, and embryo survival.

3. Conductivity

Table 3. 2000-2010 Conductivity Results

Wycamp Creek-Downstream (WPC1)	Results in $\mu\text{S}/\text{cm}$	Date
Minimum	210.7	5/2/2008
Maximum	395.5	2/9/2010
Mean	272.8	
Median	270.3	
Wycamp Creek-Upstream (WPC2)	Results in $\mu\text{S}/\text{cm}$	Date
Minimum	207.8	5/2/2008
Maximum	460.4	8/5/2010
Mean	276	
Median	267.5	

The baseline range in conductivity is relative to other creeks with similar morphology.

4. Chloride

Table 4. 2000-2010 Chloride Results

Wycamp Creek-Downstream (WPC1)	Results in mg/L	Date
Minimum	1.53	6/6/2006
Maximum	6.78	9/18/2006
Mean	3.89	
Median	3.97	
Wycamp Creek-Upstream (WPC2)	Results in mg/L	Date
Minimum	1.53	6/6/2006

Maximum	5.69	9/3/2008
Mean	3.7	
Median	3.77	

Baseline chloride ranges are low at both sites and within threshold values fully supporting all uses. Chloride concentration are slightly higher at the downstream site and is located near a road that is salted unlike the upstream site which can only be accessed through a seasonal road. See Figure 39.

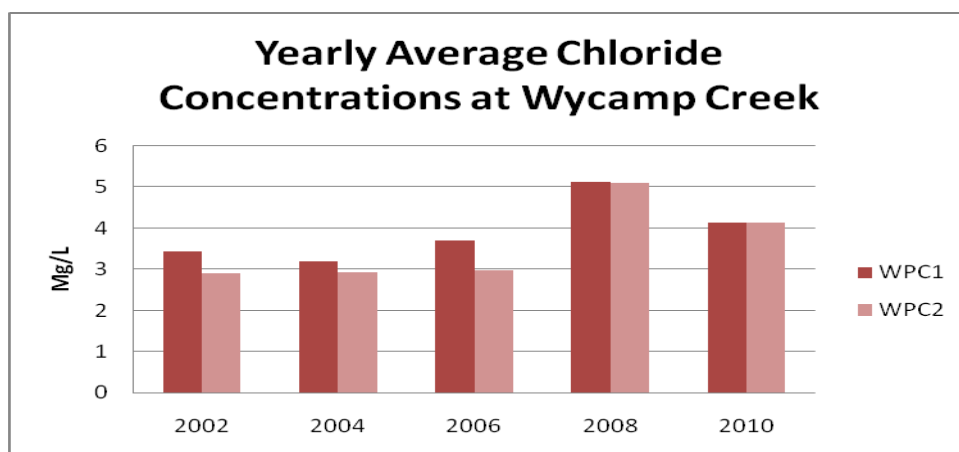


Figure 39: Yearly Average Chloride Concentrations at Wycamp Creek

5. pH

Table 5. 2000-2010 pH Results

Wycamp Creek-Downstream (WPC1)	pH Results	Date
Minimum	7.19	10/5/2000
Maximum	8.5	10/1/2010
Mean	8.07	
Median	8.13	
Wycamp Creek-Upstream (WPC2)	pH Results	Date
Minimum	7.5	9/18/2006
Maximum	8.66	10/1/2010
Mean	8.11	
Median	8.09	

Baseline pH results are within the State of Michigan recommended 6.5-9 range to support all uses.

6. Total Phosphorus

Table 6. 2000-2010 Total Phosphorus Results

Wycamp Creek-Downstream (WPC1)	Results in µg/L	Date
Minimum	2.8	7/9/2010
Maximum	14.1	8/3/2004
Mean	8.1	
Median	8.4	

Wycamp Creek-Upstream (WPC2)	Results in µg/L	Date
Minimum	7.5	9/18/2006
Maximum	8.7	10/1/2010
Mean	8.1	
Median	8.09	

Baseline total phosphorus ranges are low at both sites and are within the suggested range to be found in unpolluted waters.

7. Total Nitrogen

Table 7. 2000-2010 Total Nitrogen Results

Wycamp Creek-Downstream (WPC1)	Results in mg/L	Date
Minimum	0.04	6/3/2004
Maximum	0.96	2/15/2008
Mean	0.59	
Median	0.61	
Wycamp Creek-Upstream (WPC2)	Results in mg/L	Date
Minimum	0.01	9/4/2002
Maximum	1.033	2/19/2008
Mean	0.61	
Median	0.64	

Baseline total nitrogen results are within the suggested range found in unpolluted waters. The maximum total nitrogen results are during the winter sampling season for both sites. This may be due to an influx of groundwater after a hard freeze.

8. Total Suspended Solids (TSS)

Table 7. 2000-2010 TSS Results

Wycamp Creek-Downstream (WPC1)	Results in mg/L	Date
Minimum	0.08	9/13/2000
Maximum	17	10/3/2006
Mean	3.04	
Median	2.6	
Wycamp Creek-Upstream (WPC2)	Results in mg/L	Date
Minimum	0.1	6/3/2010
Maximum	40.4	10/3/2006
Mean	3.27	
Median	2.3	

The baseline results are within the suggested range of 0-25 mg/L to attain full support of Tribal uses with the exception of the 40.4 mg/L recorded on 10/3/06 at the upstream site. This was the day that a board was taken out early at the upstream dam during a spawning period. Waters were very turbid and waters were at high velocity rates. This instance has not reoccurred since then and may have been addressed by other LTBB NRD staff when meeting with the new dam manager.

9. Discharge Rates

Velocity measurements are taken every year during monitoring events. See Figure 40 for results of 2010 depicting discharge calculations between the upstream (WPC2) and downstream (WPC1) sites. Flows at both sites are comparable to each other and follow the same pattern with increased discharge rates in October. Winter discharge rates are not shown since shelf ice existed on WPC1 during the sampling event.

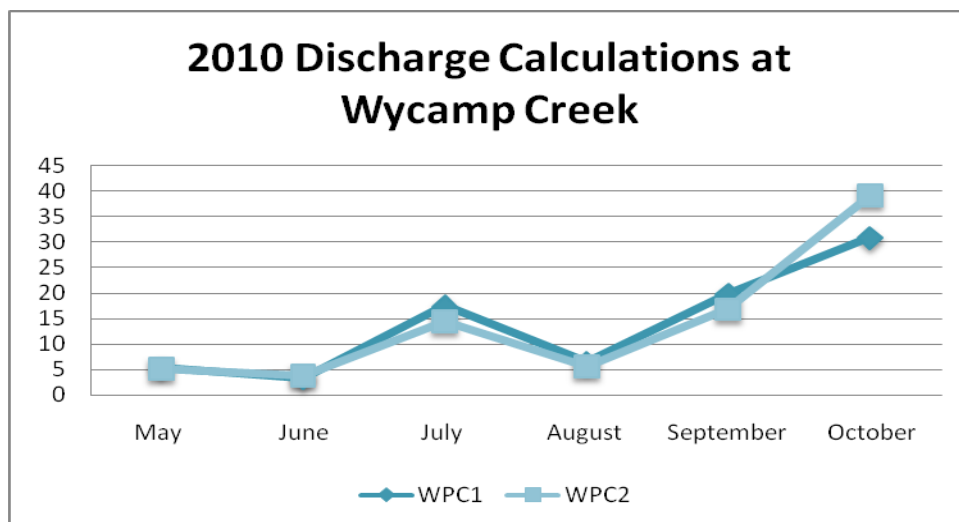


Figure 39: 2010 Discharge Calculations at Wycamp Creek

10. Habitat Assessment

The low-gradient habitat assessment conducted in 2010 at WPC2 had an overall condition category of optimal habitat with an overall score of 167 out of 180. All habitat parameters measured were within the optimal condition category except for pool variability and sediment deposition. Shallow pools are more prevalent than deep pools in this stretch of the creek so a marginal condition category was given to this habitat parameter. New sand deposition was observed during the assessment, so a marginal condition score was given under the sediment deposition habitat parameter. This is the same condition classification as all other years assessed. Sand hill cranes, blue herons, salmon and trout, and deer have been observed at this site. Bear have not been seen but are known to frequent the area.

The high-gradient habitat assessment conducted in 2010 at WPC1 had a condition category of optimal habitat. Most habitat parameters assessed were within optimal conditions. The left bank facing downstream has a steep sandy slope with little vegetation on the stream bank causing potential for sand to runoff and deposit into the creek. Therefore, bank stability, embeddedness, and riparian vegetation zone width were given a suboptimal score for the left bank. A suboptimal score was given to the velocity/depth regime since one of the four depth/velocity regimes was missing at this stretch of the creek. The optimal habitat condition score is the same as previous years in the baseline assessment. Salmon and trout migrate and spawn up this stretch of the river where the assessment is completed.

11. Macroinvertebrates

Macroinvertebrate identification for 2008 has not been completed. Past analyzed results include the following: WPC1's farthest upstream riffle (R3) 2006 had the lowest percentage of Ephemeroptera, Plecoptera, and Trichoptera (EPT) order for all years monitored. 90% of the sample was composed of Chironomids.

WPC1's riffle closest to the water quality site (R1) had only 33% of the sample composed of Chironomids but still had a lower percentage of EPT compared to other years.

WPC1's R2 in between R1 and R3 had similar results to R3. Percentage of Chironomids was 71.6% and EPT was 2.94. This was the lowest EPT percentage observed at R2 for all years monitored.

WPC2's downstream riffle (R1) has the highest Shannon-Weiner Diversity Index (SDI) in 2006 of all years monitored. However, the range was minimal from 1.86 to 2.19 throughout the years. Percentage EPT is comparable to 2004 and 2002 which are all higher than 2000. 33.3 % of the sample found consisted of Chironomids and 15% were EPT. This was the lowest percentage of chironomids found in all years monitored but there range is also minimal.

WPC2's riffle near the water quality site (R2) also had the highest SDI in 2006. Percentage of EPT has increased significantly compared to the 2004 and 2002 samples. However, 58% of the macroinvertebrate sample was EPT order in 2000.

WPC2's riffle farthest upstream (R3) had a higher SDI in 2006 compared to previous years. The percentage of EPT in 2006 had decreased by 2% compared to 2004 but increased significantly from the year 2002. In 2002, only 1.1% of the macroinvertebrate sample was of EPT orders. However, in 2000, 47% of the sample was EPT orders.

Overall, WPC2's macroinvertebrate sites dominate in trichoptera that are in the family, hydropsychidae when only analyzing the composition of EPT. Due to the variance of metric results from year to year an increase or decrease in perturbation cannot be implied.

E. Conclusion and/or Recommendations

Monitoring will continue on a seasonal basis every other year due to high use by Tribal citizens. Inspection and observations at the upstream site where the dam is located may be more frequent during times of spawning to ensure optimal conditions. The LTBB WQS will meet with the LTBB Inland Fisheries and Wildlife staff to discuss conducting a future fish and water quality survey to determine whether or not anadromous salmonids are succeeding in reproduction. It is still unclear whether or not fish spawning are successful in reproduction. Recommendations to submerge temperature probes for a long-term temperature fluctuation study in areas not currently monitored will also be discussed amongst NRD staff.

2. Five Mile Creek

A. Site Description and Background

Five Mile Creek is the second largest tributary of Little Traverse Bay, and is a cold water spring-fed perennial creek. The creek has a heavily shaded canopy through most of the land it meanders keeping the water cool. The creek flows into a trout pond, then into an old mill pond. Both ponds are on private land. After the private land, the creek flows through a cedar swamp owned by the local conservancy and meanders through forested private land until it discharges into Little Traverse Bay. Five Mile Creek is approximately 1.8 miles in length. There is a monitoring site upstream (FMC2) with a cross section width of 6.7 meters below the mill pond and a site downstream by the mouth of the creek (FMC1) with a cross section width of 2.9 meters. The LTBB WQS was given permission by the land owner to monitor at both sites. The

WQS has in turn supplied the land owner access to the water quality information collected and is informed by the landowner of any water quality issues concerning Five Mile Creek.

B. Tribal Use and Management

Both sites have a LTBB draft primary use of a cold water fishery. Five Mile Creek is listed as a Designated Trout Stream under the authority Section 48701 by the MDNRE. Common fish living in the creek include but are not limited to: rainbow, brown, and brook trout. Other designated uses are primary contact recreational and indigenous aquatic life and wildlife.

There is a concern about where the influx of total phosphorus during the months of August and September are coming from.

C. 2010 Tribal Use Attainment

All uses were given full support attainment for all Tribal Uses. Temperatures are below the optimum growth threshold for rainbow trout during all monitoring events. Temperatures did exceed embryo survival and optimum spawning during summer monitoring events. However, monitoring is done during warmest times of the day and the suggested temperature criteria are for optimum conditions. In August, a high total phosphorus concentration was recorded at the upstream site and a higher than average total phosphorus was found at the downstream site. All other parameters were within the threshold values used to assess support attainment in this report.

D. Parameter Results & Baseline Analysis

1. Dissolved Oxygen

Table 1. 2002-2010 Dissolved Oxygen Results

Five Mile Creek-Downstream (FMC1)	Results in mg/L	Date
Minimum	9.1	8/2/2006
Maximum	13.83	2/25/2010
Mean	10.95	
Median	10.66	
Five Mile Creek-Upstream (FMC2)	Results in mg/L	Date
Minimum	8.6	8/2/2006
Maximum	12.83	8/12/2002
Mean	10.53	
Median	10.4	

Dissolved oxygen concentrations were above the suggested 7 mg/L for a cold water fishery during each baseline monitoring event.

2. Temperature

Table 2. 2002-2010 Temperature Results

Five Mile Creek-Downstream (FMC1)	Results in °C	Date
Minimum	1.13	2/25/2010
Maximum	17.26	8/2/2006
Mean	11.19	
Median	11.38	
Five Mile Creek-Upstream (FMC2)	Results in °C	Date

Minimum	1.54	2/25/2010
Maximum	17.1	8/2/2006
Mean	11.32	
Median	11.5	

The charts below show the optimum threshold temperatures for rainbow trout growth (black line), spawning (red line), and embryo survival (green). Fish require temperatures below the respective thresholds for their life stages. See Figures 41 and 42.

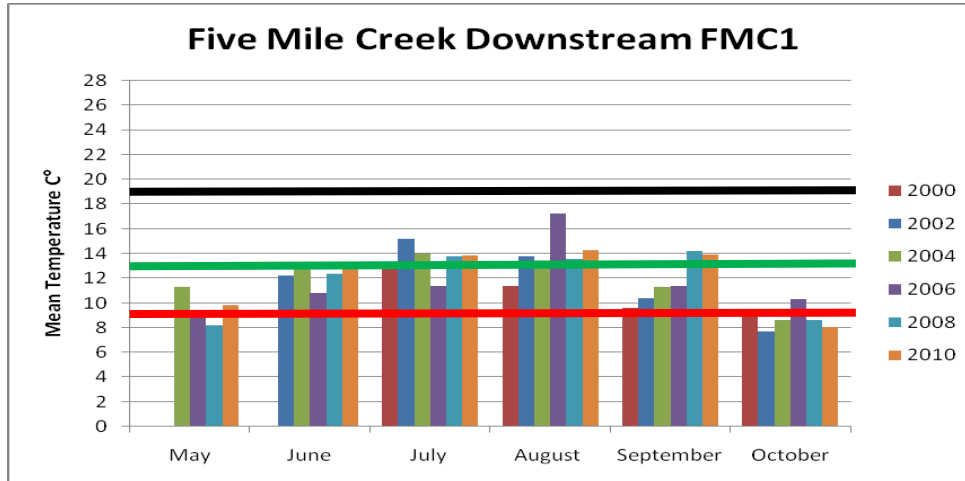


Figure 41: Five Mile Creek Downstream FMC1

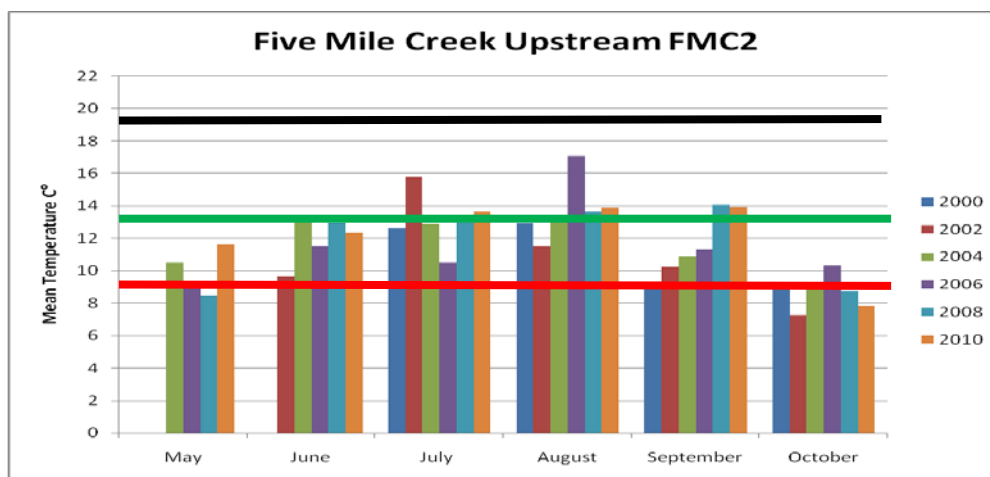


Figure 42: Five Mile Creek Upstream FMC2

LTBB water staff has seen salmon and trout downstream of FMC1. Whether or not the anadromous salmonids migrate up to FMC2 has not been confirmed. Mean yearly temperatures are always within the suggested optimum condition for rainbow trout growth, within or just above optimum conditions for spawning during May and October when there is active spawning, and optimum embryo survival conditions were usually below the threshold during spring and fall exceeding in some years during summer months.

3. Conductivity

Table 3. 2002-2010 Conductivity Results

Five Mile Creek-Downstream (FMC1)	Results in $\mu\text{S}/\text{cm}$	Date
Minimum	8.45	9/2/2010
Maximum	385.03	8/1/2008
Mean	336.38	
Median	352.77	
Five Mile Creek-Upstream (FMC2)	Results in $\mu\text{S}/\text{cm}$	Date
Minimum	10.01	6/20/2002
Maximum	373.56	6/11/10
Mean	309.25	
Median	330.91	

The baseline maximum conductivity results at both sites are relative to other creeks with similar morphology however, the minimum readings are very low. This is not a concern for water quality conditions but seems low when considering the flow and runoff from both ponds upstream. Since both sites have comparable minimum concentrations the reading being caused by faulty equipment is nominal.

4. Chloride

Table 4. 2002-2010 Chloride Results

Five Mile Creek-Downstream (FMC1)	Results in mg/L	Date
Minimum	3.4	9/22/2004
Maximum	8.51	6/4/2008
Mean	5.97	
Median	5.93	
Five Mile Creek-Upstream (FMC2)	Results in mg/L	Date
Minimum	2.7	9/22/2004
Maximum	6.6	5/7/2008
Mean	4.26	
Median	4	

Baseline chloride conditions are low and have a minimal range. Chloride is of low concern to impacting water quality on this creek.

5. pH

Table 5. 2002-2010 pH Results

Five Mile Creek-Downstream (FMC1)	pH Results	Date
Minimum	7.93	10/4/2010
Maximum	8.95	5/13/2004
Mean	8.34	
Median	8.3	
Five Mile Creek-Upstream (FMC2)	pH Results	Date
Minimum	7.82	8/2/2006
Maximum	8.78	2/25/2010
Mean	8.16	
Median	8.13	

Baseline pH results are within the State of Michigan recommended 6.5-9 range to support all uses.

6. Total Phosphorus

Table 6. 2002-2010 Total Phosphorus Results

Five Mile Creek-Downstream (FMC1)	Results in µg/L	Date
Minimum	4.2	10/3/2008
Maximum	36.9	8/2/2006
Mean	11.61	
Median	8.8	
Five Mile Creek-Upstream (FMC2)	Results in µg/L	Date
Minimum	3.7	5/7/2008
Maximum	65.2	8/2/2010
Mean	12.34	
Median	8.8	

Total phosphorus results are usually within the range found in unpolluted waters with the exception of the maximum concentration reading recorded at FMC2 in August of 2010. Increased phosphorus concentrations are seen during most years in August and at times in September. Future data will be reviewed to see if these increased concentrations continue during these months. If they continue to increase and are above 50 µg/L, possible sources will be investigated by the LTBB WQS and outcomes of the investigation will be documented in future water quality assessment reports.

7. Total Nitrogen

Table 7. 2002-2010 Total Nitrogen Results

Five Mile Creek-Downstream (FMC1)	Results in mg/L	Date
Minimum	0.6	6/4/2008
Maximum	1.35	8/2/2006
Mean	0.91	
Median	0.87	
Five Mile Creek-Upstream (FMC2)	Results in mg/L	Date
Minimum	0.56	6/4/2008
Maximum	1.42	8/2/2010
Mean	0.90	
Median	0.83	

Baseline total nitrogen results are within the suggested range found in unpolluted waters. The maximum total nitrogen results are also detected in the month of August within the years of the baseline assessment, which is similar to the maximum concentrations for total phosphorus occurring at both sites in August. However, these maximum concentrations are still considered minimal in terms of affecting water quality.

8. Total Suspended Solids (TSS)

Table 7. 2002-2010 TSS Results

Five Mile Creek-Downstream (FMC1)	Results in mg/L	Date
Minimum	1.0	10/4/2010
Maximum	43.9	8/2/2006

Mean	6.9	
Median	4.2	
Five Mile Creek-Upstream (FMC2)	Results in mg/L	Date
Minimum	0.1	10/3/2008
Maximum	54.88	8/2/2010
Mean	6.38	
Median	3.28	

The baseline results were within the suggested range of 0-25 mg/L except for the months maximum concentrations were recorded and one other exceedence in August of 2010 at FMC1. All nutrient results and total suspended solids share the pattern of increases in the months of August and in some years in September. This pattern will be assessed after every year of future monitoring at these sites.

9. Discharge Rates

Velocity measurements are taken every year during monitoring events. See Figure 43 for results of 2010 depicting discharge calculations between the upstream (FMC2) and downstream (FMC1) sites. Flow rates follow the same pattern at both sites except in June where the upstream site decreases slightly while the downstream flow increases and in June where the flow decreases downstream and increases upstream.

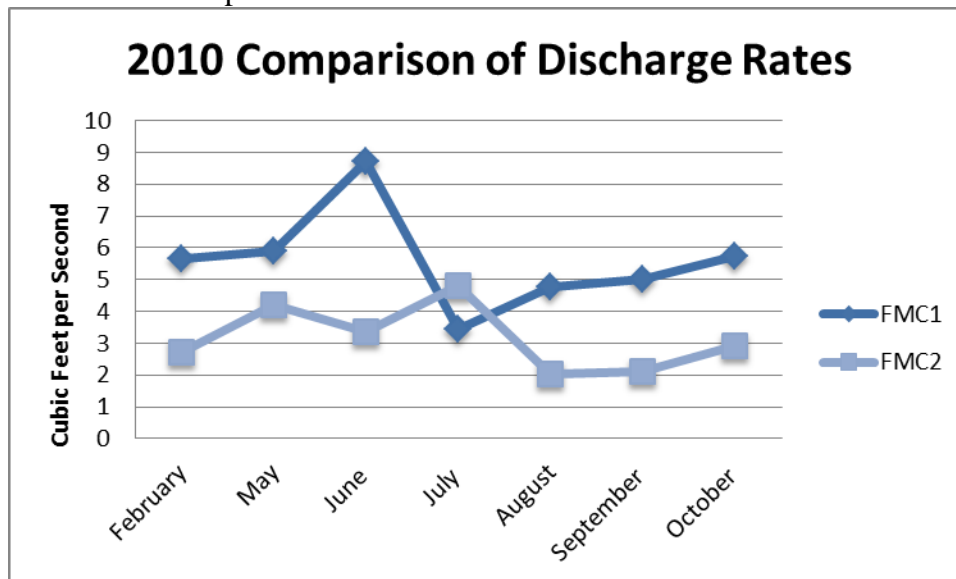


Figure 43: 2010 Comparison of Discharge Rates

10. Habitat Assessment

The low gradient habitat assessment conducted in 2010 at FMC2 had an overall rating of optimal habitat conditions. Scores in each habitat parameter during the baseline assessment yielded very little change from year to year. The area where this monitoring site is located is privately owned and the land use is as a park for seasonal and residential homeowners living in this subdivision. As long as the land use does not change in the future on this parcel of land, habitat conditions will continue to be optimal.

The high gradient habitat assessment score for FMC1 conducted in 2010 was in the optimal condition category. This site's condition category has not changed throughout the

baseline assessment. There is a road crossing culvert at this site, which could use improvements in the future. Overall this site provides good habitat for coldwater species due to the area being partially shaded, adequate flow, cobble/gravel substrate, meandering pattern, and woody debris. Wildlife observed by residents living adjacent to the creek and by LTBB water quality staff include but are not limited to: deer, black bear, mink and bobcat.

11. Macroinvertebrates

Macroinvertebrate identification for 2008 has not been completed. Past analyzed results include the following:

There have always been a percentage of the orders Ephemeroptera, Plecoptera, and Trichoptera (EPT) identified at both of the sites on this creek. At least 11 percent of the samples at FMC2 and at least 6 percent at FMC1 are composed of EPT orders. These are the minimal percentage seen during the baseline assessment. There is not a clear increase or decrease of perturbation between metrics calculated for 2002, 2004, & 2006. Once results are calculated for samples collected in 2008 & 2010, trends will be analyzed for any change in water quality based on the macroinvertebrate survey.

Based on order, family, and genus composition, Five Mile Creek supports coldwater genera and has the highest diversity of EPT at any cold water creek monitored in the LTBB Surface Water Quality Program. Many of the plecoptera and trichoptera genera found in Five Mile Creek need cold water, high velocity and no pollution.

E. Conclusion and/or Recommendations

Five Mile Creek can be considered the most pristine cold water creek monitored in the baseline assessment. Substrate, flow conditions, adjacent wetlands, undisturbed riparian zones, temperature, and dissolved oxygen results determine this creek to be in optimal condition for coldwater aquatic life.

Concerns relating to this creek are upstream land use impacts and the influxes of nutrients and total suspended solids (TSS) in the months of August and September indicated during the baseline assessment. An additional site, located just below the mill and trout pond, has been added to the monitoring design upstream of FMC2. Monitoring results from this additional site will be analyzed and compared to the other two sites' future results to see if this pattern continues and whether or not nutrient and TSS results are higher at the new site.

3. Tannery Creek

A. Site Description and Background

Tannery Creek is the third largest tributary to Little Traverse Bay. It is a perennial spring fed creek. This creek is the most highly impacted creek in the LTBB monitoring program within the Little Traverse Bay watershed. The creek meanders through agricultural land, a golf course, and areas of dense development. All land surrounding the creek is owned privately except for a right of way located at the mouth of the creek. Impervious concrete is part of the substrate composition in the downstream areas of the creek. These concrete foundations are said to be remnants of the old tannery. Cutoff pipes above and within the creek are also present near the downstream site.

Tannery Creek was named after the tannery that was located adjacent to the creek. When the tannery was in operation it has been said that Tannery Creek was highly polluted due to the

continuous discharge of toxic tannery waste into the creek. This historical overview is purely documented from verbal accounts.

Tannery Creek is approximately 1.71 miles long. There are two active monitoring sites on Tannery Creek, located upstream and downstream. In 2002, the upstream site known as TYC2 was eliminated due to a denial of access by the landowner. In 2004 another upstream site (TYC2A) was chosen and monitoring has continued at this site since then. TYC2A has a cross section of approximately 2.74 meters and TYC1 has a cross section of approximately 3 meters across. Please note that TYC1A was not monitored during the baseline assessment and it will take the place of TYC1 in the future monitoring design.

B. Tribal Use and Management

The draft primary and designated Tribal uses assigned to the creek are the same at both sites. The draft primary use is as a cold water fishery. Draft designated uses are partial/secondary contact recreational and indigenous aquatic life and wildlife.

The Tribe has and will continue to collaborate with Tip of the Mitt Watershed Council in seeking implementation funds to restore, stabilize, and clean up areas within the creek and adjacent to the creek. As mentioned above, it is the most impacted creek in terms of degradation of water quality and habitat.

C. 2010 Tribal Use Attainment

Temperatures exceed the referenced temperature thresholds used for this assessment for optimum embryo survival and spawning for rainbow trout in 2010 but not for optimum trout growth. Exceedences only occurred in the summer months and monitoring events are completed during warmer periods of a day. Based on these factors, the degree of full support is attained. All other parameters are within thresholds used for assessment in this report.

D. Parameter Results & Baseline Analysis

Parameter results and baseline analysis will only be conducted in this baseline assessment for sites TYC2A and TYC1. Statistical analysis on TYC1 will include the even years between 2002-2010 and only 2006-2010 for TYC2A. Since TYC2 was eliminated as a site and sampling was not consistent in year 2000, data results will not be discussed for that site. However, TYC2 results are available and have been discussed in previous water quality assessment reports prior to elimination of monitoring.

1. Dissolved Oxygen

Table 1. Dissolved Oxygen Results

Tannery Creek-Downstream (TYC1)	Results in mg/L	Date
Minimum	8.3	9/16/2004
Maximum	13.5	3/8/2010
Mean	10.3	
Median	9.9	
*Tannery Creek-Upstream (TYC2a)	Results in mg/L	Date
Minimum	8.07	5/11/2006
Maximum	12.4	2/10/2010
Mean		
Median		

Dissolved oxygen concentrations have always been above the recommended temperature of 7 mg/L for cold water fish.

2. Temperature

Table 2. Temperature Results

Tannery Creek-Downstream (TYC1)	Results in °C	Date
Minimum	2.6	3/8/2010
Maximum	18.67	8/9/2010
Mean	12.09	
Median	11.64	
Tannery Creek-Upstream (TYC2a)	Results in °C	Date
Minimum	2.82	2/10/2010
Maximum	16.97	8/7/2008
Mean	12.3	
Median	12.9	

The charts below show the optimum threshold temperatures for rainbow trout growth (black line), spawning (red line), and embryo survival (green). Fish require temperatures below the respective thresholds for their life stages. See Figures 44 and 45.

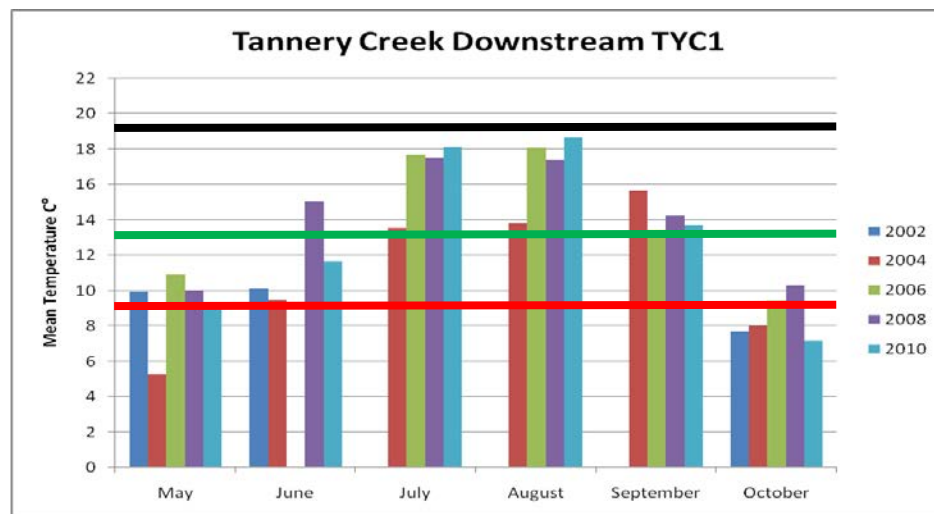


Figure 44: Tannery Creek Downstream TYC1

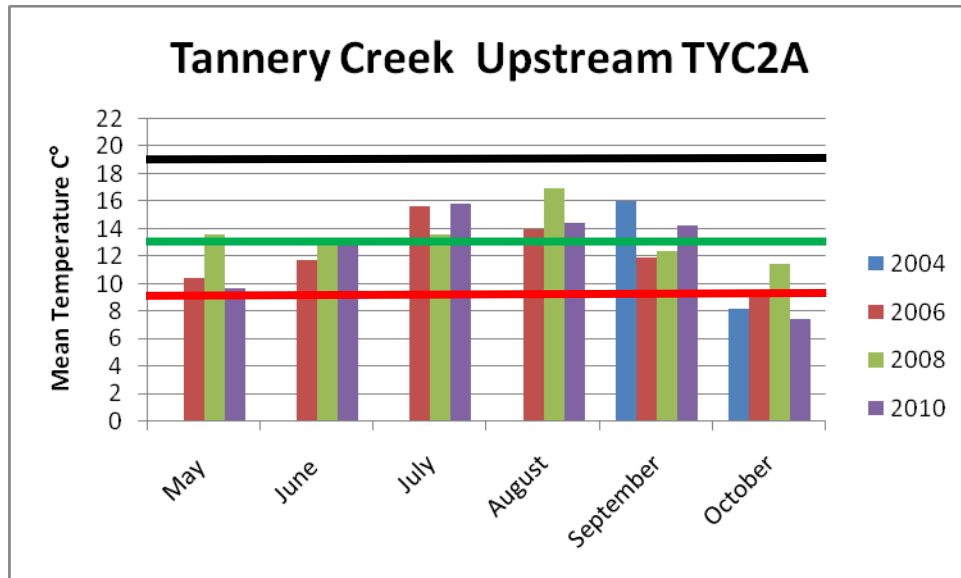


Figure 45: Tannery Creek Upstream TYC2A

Mean temperatures are below the optimum growth for rainbow trout during all monitoring events during the baseline assessment at both upstream and downstream sites. Optimum embryo survival conditions exceed only in the summer months at TYC1 and occur during the majority of the months sampled during the baseline assessment at TYC2A. During most monitoring events optimum spawning thresholds were exceeded at both sites.

3. Conductivity

Table 3. Conductivity Results

Tannery Creek-Downstream (TYC1)	Results in $\mu\text{S}/\text{cm}$	Date
Minimum	437.45	5/7/2002
Maximum	621.18	9/9/2010
Mean	531.2	
Median	547.7	
Tannery Creek-Upstream (TYC2A)	Results in $\mu\text{S}/\text{cm}$	Date
Minimum	343.7	5/11/2006
Maximum	550.02	8/7/2008
Mean	517.91	
Median	528.83	

The baseline conductivity range is higher than other cold water creeks monitored in the baseline assessment. There are significant trends at both sites that conductivity results are increasing over time at both sites as depicted in see Figure 46.

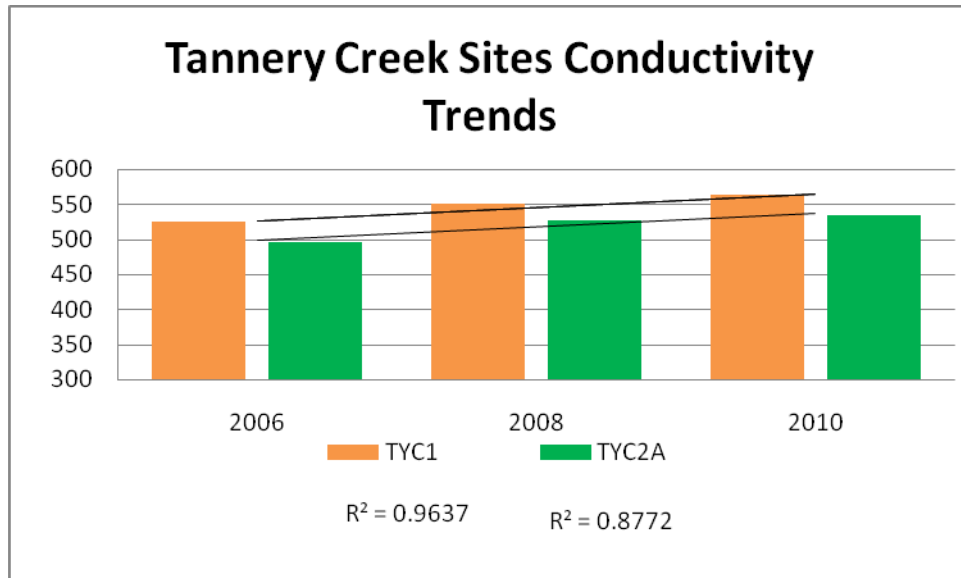


Figure 46: Tannery Creek Sites Conductivity Trends

4. Chloride

Table 4. Chloride Results

Tannery Creek-Downstream (TYC1)	Results in mg/L	Date
Minimum	17.7	6/4/2002
Maximum	48.25	3/8/2010
Mean	29.81	
Median	29.2	
Tannery Creek-Upstream (TYC2A)	Results in mg/L	Date
Minimum	16.14	8/9/2006
Maximum	24.2	5/2/2008
Mean	18.38	
Median	19.01	

The range of chloride results is wider at the downstream site, TYC1 than the upstream site, TYC2A. This wider range and higher maximum result at TYC1 may be due to impacts of land use activities above the downstream site. There is also a trend that chloride has increased over time at TYC1, please see Figure 47.

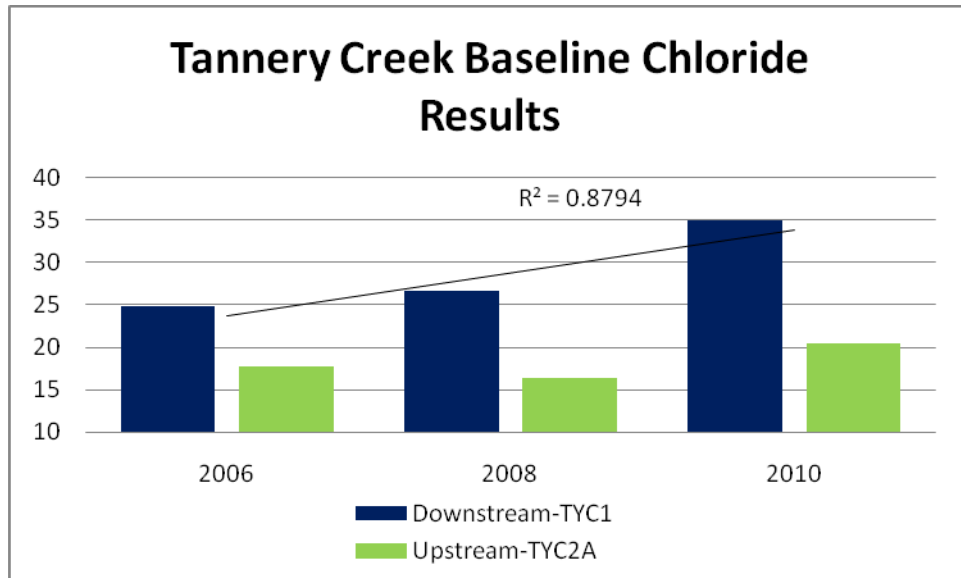


Figure 47: Tannery Creek Baseline Chloride Results

The Pearson Correlation method was used to indicate whether or not there was a correlation between conductivity and chloride at TYC1. Results indicated there was not a correlation. Chloride results are within the acceptable range used to assess the baseline data.

5. pH

Table 5. pH Results

Tannery Creek-Downstream (TYC1)	pH Results	Date
Minimum	7.78	5/7/2002
Maximum	8.93	3/8/2010
Mean	8.26	
Median	8.29	
Tannery Creek-Upstream (TYC2A)	pH Results	Date
Minimum	7.4	5/11/2006
Maximum	8.01	2/10/2010
Mean	7.75	
Median	7.8	

Baseline pH results are within the State of Michigan recommended 6.5-9 range to support all uses. Both sites indicate that pH results are higher in the winter months than during the other seasons.

6. Total Phosphorus

Table 6. Total Phosphorus Results

Tannery Creek-Downstream (TYC1)	Results in $\mu\text{g/L}$	Date
Minimum	2.7	10/15/2002
Maximum	152	5/11/2006
Mean	18.89	
Median	11.15	

Tannery Creek-Upstream (TYC2A)	Results in µg/L	Date
Minimum	1.8	10/2/2008
Maximum	27.2	5/11/2006
Mean	6.81	
Median	5.2	

Total phosphorus baseline mean and median results are within the range found in unpolluted waters. The maximum total phosphorus reading recorded at TYC1 in May of 2006 was investigated for transcription errors. There were no transcription errors found and a duplicate taken at TYC1 from the same water sample was also analyzed for total phosphorus resulting in the same concentration. Therefore, the result is assumed to be correct. The maximum total phosphorus concentrations also occurred on the same date at both sites.

7. Total Nitrogen

Table 7. Total Nitrogen Results

Tannery Creek-Downstream (TYC1)	Results in mg/L	Date
Minimum	0.67	6/7/2010
Maximum	2.38	5/11/2006
Mean	1.298	
Median	1.295	
Tannery Creek-Upstream (TYC2A)	Results in mg/L	Date
Minimum	0.63	2/10/2010
Maximum	1.6	8/9/2010
Mean	0.998	
Median	1.02	

Baseline total nitrogen results are within the suggested range found in unpolluted waters. The maximum total nitrogen results for TYC1 occur on the same date as the maximum total phosphorus reading. Regression trends ($R^2=0.78$) indicate that TYC2A total nitrogen yearly averages have decreased over time. Note: This trend is only for three years of data collection. If TYC1 data was analyzed for trends using only 2006-2010 data, it would have shown the same outcome as TYC2A. See Figure 48.

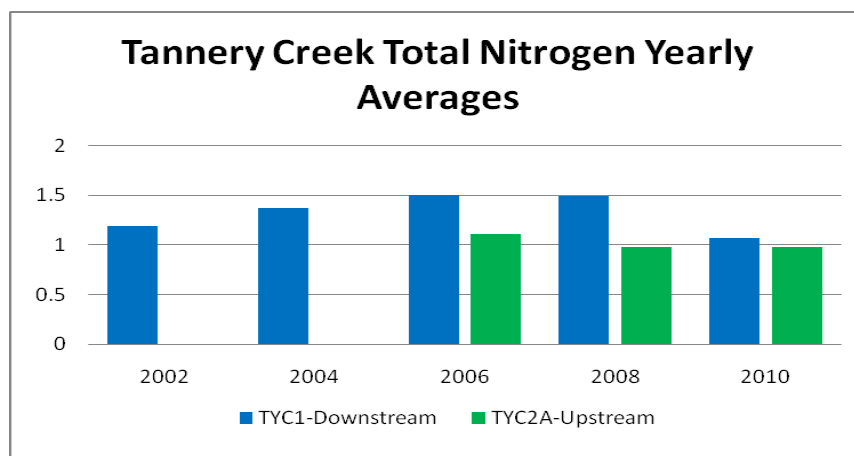


Figure 48: Tannery Creek Total Nitrogen Yearly Averages

8. Total Suspended Solids (TSS)

Table 7. TSS Results

Tannery Creek-Downstream (TYC1)		Results in mg/L	Date
Minimum		0.5	10/15/2002
Maximum		117.35	5/11/2006
Mean		13.50	
Median		7.15	
Tannery Creek-Upstream (TYC2A)		Results in mg/L	Date
Minimum		0.8	9/4/2008
Maximum		24.2	5/8/2008
Mean		5.06	
Median		3.1	

The mean and median results for both sites were within the suggested range of 0-25 mg/L. Individual monitoring events indicate there have been two exceedences at TYC1 and none at TYC2A during the baseline assessment. One of the exceedences being the maximum concentration recorded on the same day and year as the maximum results for total phosphorus and nitrogen, clearly indicating an influx of nutrients and solids on this day. There was precipitation and rain on this sampling day but after sampling had occurred. Rain was recorded the night before sampling which may have increased the concentrations of these parameters from an unidentified upstream source. The second exceedence was in August of 2008. The exceedence was minimal, reporting a TSS concentration of 30.55 mg/L. As indicated for total nitrogen there is a trend ($R^2=0.798$) of TSS decreasing over time at TYC2A. Note: Only three years of data collection used for trend analysis. See Figure 49.

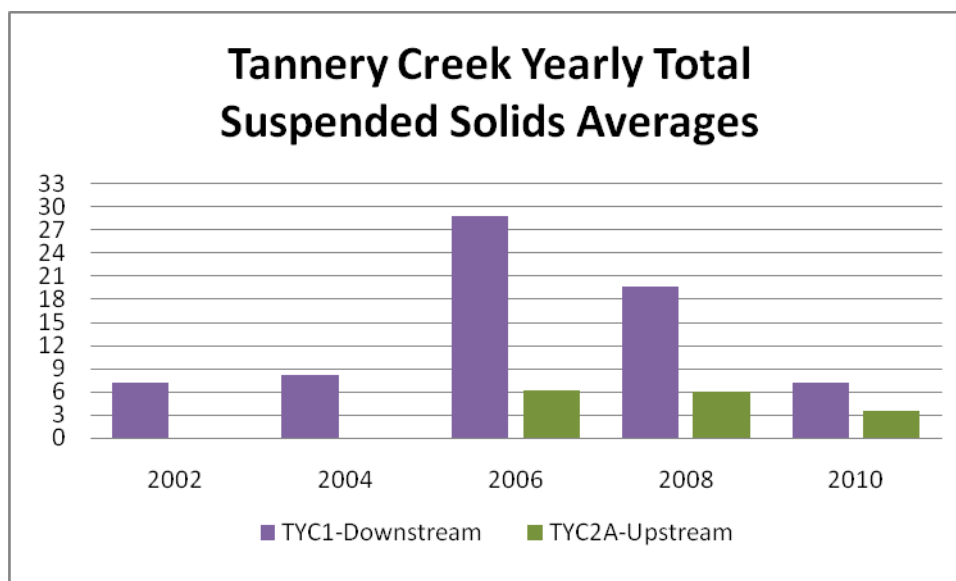


Figure 49: Tannery Creek Yearly Total Suspended Solids Averages

9. Discharge Rates

Velocity measurements are taken every year during monitoring events, see Figure 50. Flow rates follow the same pattern at both sites. However, velocity readings were not recorded at TYC2A in August and September since readings were negative. Past data was reviewed for the

May 2006 monitoring event that resulted in high concentrations of nutrients and total suspended solids; the discharge at TYC1 that day was 12.2 cubic ft/second. This discharge rate is very high for this creek, increasing conditions that compliment runoff conditions during rain events.

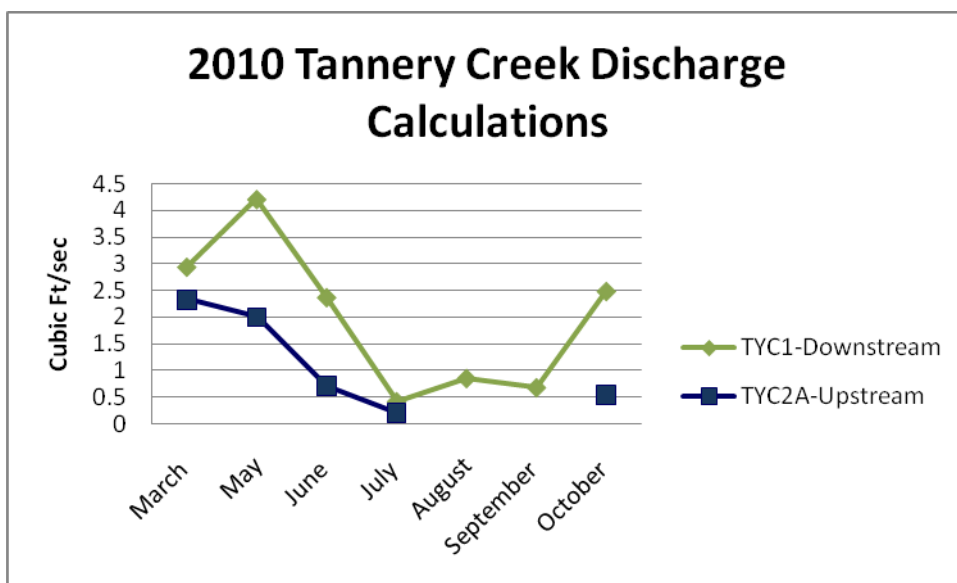


Figure 50: 2010 Tannery Creek Discharge Calculations

10. Habitat Assessment

The high gradient habitat assessment conducted in 2010 at TYC1 had an overall rating of suboptimal habitat conditions. The overall score decreased from the score given in 2008, but it is higher than the scores given in 2004 and 2006 by a small margin. All score throughout the years have been within suboptimal condition category.

There appeared to be more sediment deposition present at this site than noted in 2008. The habitat parameter channel flow status received a marginal score due to increased exposure of substrate around bends. The riparian vegetation zone widths for both sides of the stream bank received marginal scores in 2010 while suboptimal conditions were reported in 2008. There has been increased foot traffic and human activity affecting the stream banks at this site over the years.

The low gradient habitat assessment conducted in 2010 and 2008 at TYC2A had an overall score of optimal conditions. The score had increased slightly in 2010 compared to 2008. There was an increase in epifaunal substrate/available cover compared to the rating given in 2008. New fall in the form of woody debris and aquatic vegetation such as wild celery increased slightly at this site. Pool variability score had increased as well. This site location is privately owned and is relatively undisturbed by land use activities that are seen downstream.

11. Macroinvertebrates

Macroinvertebrate data has only been taken in 2008 at TYC1. The 2008 sample will be compared to past data at TYC2A and data taken at TYC1 in 2010. The TYC1 sample was taken in the right of way of the monitoring site. Only one sample was collected at this specific location due to access issues upstream of the monitoring site. Due to this access issue, the downstream monitoring site will change in the next workplan so macroinvertebrates can be collected as well

as any other surveys that coincide with monitoring data that will increase the strength of determining water quality conditions.

A macroinvertebrate sample is taken at TYC2A at different sediment substrates. The results are combined. However there are only two sets of data that can be assessed since 2008 macroinvertebrates have not been identified yet. The Shannon-Weiner Diversity Index Score was higher in 2006 than 2004. The diversity score may be correlated to the 2006 increased percentage of Chironomidae and different genera within this family. The dominant taxon percentage was lower in 2006 than 2004. The dominant taxon for both years is Amphipoda Gammaridae *Gammarus*. TYC2A's substrate includes vegetation and snags ideal for this dominant taxon. The percentage of Ephemeroptera, Plecoptera, and Trichoptera, decreased in 2006. In 2006, only two genus of order Trichoptera were collected while in 2004, five genera of the same order were found. One of the genera, *Lepidostoma* found in 2006, is an indicator of good water quality due to its intolerance to nutrient pollution and need for cold water. There were not any Trichoptera Hydropsychidae identified in 2006 where as there were 33% Hydropsychidae found in the 2004 collection. Two genera of the order Ephemeroptera were collected in 2004 and none were reported in the 2006 sample.

E. Conclusion and/or Recommendations

LTBB is a partner in the EPA approved Little Traverse Bay (LTB) Watershed Plan. One of the recommendations in the LTB plan is to restore the natural stream channel and aquatic habitat of Tannery Creek. Above the LTBB downstream monitoring site, lies concrete from old infrastructure within the streambed, old rusty pipes within the creek and above the creek, and there is severe head-cutting erosion at the end of a culvert present downstream of the monitoring site. Invasive plant species plague the riparian zone around the downstream site. These invasives are: common buckthorn, black swallowwort, and Japanese knotweed. LTBB and partners will continue to seek grant opportunities to address this recommendation. Currently LTBB is collaborating with Tip of the Mitt Watershed Council to secure funds from various agencies to pursue restoration efforts. LTBB will address impacts on Tannery Creek in their Non-Point Assessment Report and Management Plan to be completed in the near future. The completion of these activities is dependent on whether LTBB is awarded funds and if the landowner wishes to collaborate with the Tribe.

Monitoring will continue seasonally, every other year. If future data results indicate increasing trends or exceedences, the monitoring design may be revised to address these findings. The downstream site will be moved farther downstream near the mouth of the creek in order to collect macroinvertebrates and minimize access issues. LTBB will continue to collaborate with of Tip of the Mitt Watershed Council and the LTB Watershed plan committee members on data sharing, collaboration, assessments, and implementation efforts that could increase the water quality and Tribal uses of this creek.

4. Susan Creek

A. Site Description and Background

Susan Creek is an intermittent stream that originates at Susan Lake and flows into Lake Michigan. Much of the area that Susan Creek runs through is privately owned; the land use and cover are forested wetland, agricultural, residential, industrial, conservancy land. Fifty-five acres

of this conservancy land is a LTBB Tribal Natural Area. Susan Creek is approximately 1.87 miles long.

This geographic area surrounding Susan Lake and Susan Creek has cultural significance to the Tribe. This area was traveled by the Odawa bands when migrating north; there is still a Native American church and burial ground near the headwaters, and the creek was used for fishing, hunting, and gathering. Spear fishing was an active way to fish for trout, steelhead and suckers during the spring and fall runs (when salmon and trout would attempt to spawn) in Susan Creek. The LTBB Taimi Hoag Natural Area is still used and open to Tribal citizens for fishing, hunting, and gathering.

There have been three monitoring sites on Susan Creek during the duration of the baseline assessment. SNC1, the downstream site, is located close to the mouth of the creek and is adjacent to Highway US 31 North. SNC1's cross-section width is approximately 4 meters across during fall and spring when water levels reach both banks. SNC2A is located upstream from SNC1 on property owned by the Little Traverse Conservancy. SNC2A's cross-section width is approximately 3 meters when water flow and levels are optimum. SNC2A is an alternative site to the original upstream site SNC2. The stagnant water at SNC2 shares statistically similar water quality with Susan Lake. Therefore, SNC2 was eliminated and replaced with the site SNC2A in 2007.

B. Tribal Use and Management

The draft tribal primary use for Susan Creek is a warm water fishery with migratory routes for anadromous salmonids. Other designated uses include indigenous aquatic life and wildlife, partial/secondary contact recreational, and cultural/ceremonial uses.

The Tribe manages the area of the creek that is within LTBB Taimi Hoag Natural Area and collaborates with the Little Traverse Conservancy in maintaining the trails and any other upkeep within these areas. Tribal Citizens can receive licenses for the LTBB Natural Resource Department to hunt, fish, and gather on the natural area property. These properties are adjacent to each other linking the properties through trails.

C. 2009 Tribal Use Attainment

Temperatures exceed the referenced temperature thresholds used for this assessment for optimum embryo survival during summer months at SNC1 and during all months except for October at SNC2A. Both sites exceeded temperatures recommended for optimum spawning conditions throughout the 2009 field season. Temperature results were below the optimum trout growth threshold used in this assessment at both sites evaluated.

All other parameters are below the criterion used to assess the degree of support for Tribal uses. Therefore, this site will be given full support on all uses and will be given a need for further evaluation for warm water fishery with migratory routes for anadromous salmonids. Historically, Tribal citizens fished the creek for salmon and trout. It is unknown by the LTBB WQS the type of fish species, amount, and whether or not the creek still has ample number of anadromous salmonids migrating up the creek to spawn. The LTBB WQs will meet with other Natural Resource staff to discuss whether or not any fish surveys have been conducted and their current knowledge of fish species inhabiting this creek.

D. Parameter Results & Baseline Assessment

SNC1 and SNC2A results will only be discussed in this section. Since results for SNC2 replicate the results at Susan Lake they will not be evaluated in this report. SNC2 results have been discussed in previous water quality assessment reports and are available upon request. Data analysis will begin in June of 2007 for SNC2A. This is the month that EPA Region 5 Water Division approved the amendment to monitor this site. Since there is only 2 years of data on SNC2A, trend analysis will not be conducted.

1. Dissolved Oxygen

Table 1. 2001-2009 Dissolved Oxygen Results

Susan Creek-Downstream (SNC1)	Results in mg/L	Date
Minimum	7.67	7/24/2001
Maximum	11.9	10/2/2003
Mean	9.73	
Median	9.82	
2007 & 2009 Dissolved Oxygen Results		
Susan Creek-Upstream (SNC2A)	Results in mg/L	Date
Minimum	8.09	6/26/2007
Maximum	11.4	10/24/2007
Mean	9.59	
Median	9.55	

Dissolved oxygen concentrations have always been above the recommended temperature of 5 mg/L as a minimum during periods of migration for warm water fisheries with migratory routes for anadromous salmonids.

2. Temperature

Table 2. 2007 & 2009 Temperature Results

Susan Creek-Downstream (SNC1)	Results in °C	Date
Minimum	6.45	10/29/2001
Maximum	23.8	7/24/2001
Mean	15.13	
Median	15.44	
2007 & 2009 Temperature Results		
Susan Creek-Upstream (SNC2A)	Results in °C	Date
Minimum	9.77	10/2/2009
Maximum	21.86	6/26/2007
Mean	15.88	
Median	16.08	

The chart below shows the optimum threshold temperatures for rainbow trout growth (black line), spawning (red line), and embryo survival (green) for SNC1 only. More temperature data collection will be needed to fully assess the baseline temperatures specific to fish species. See Figure 51.

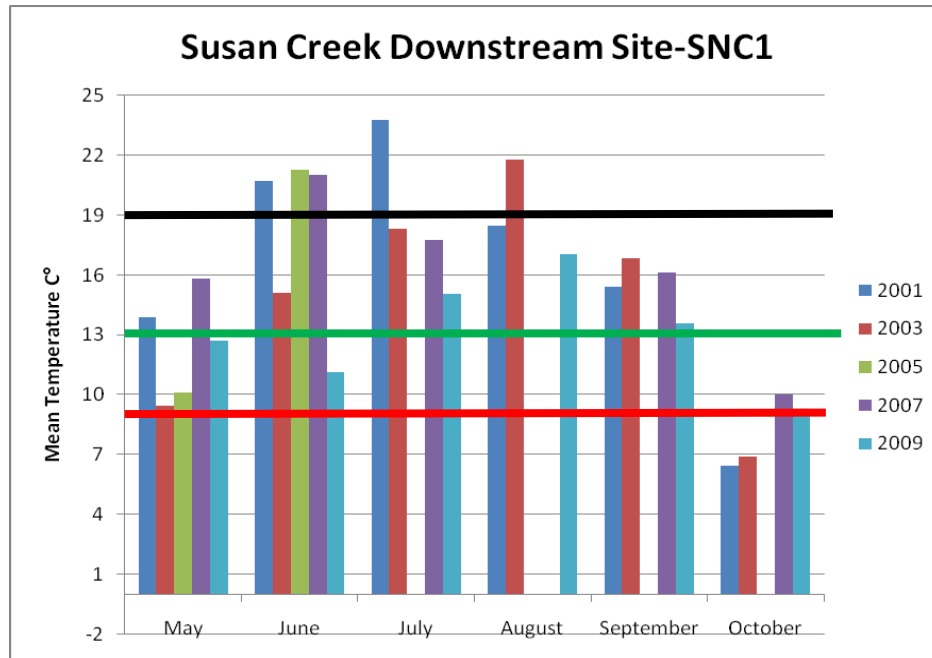


Figure 51: Susan Creek Downstream Site-SNC1

In years prior to 2009, the recommended temperature threshold for growth has been exceeded during at least one month in the summer. The majority of data exceeds embryo survival most years in all months except October. The spawning threshold was exceeded during each field season except for in the month of October, which is a spawning month.

3. Conductivity

Table 3. 2001-2009 Conductivity Results

Susan Creek-Downstream (SNC1)	Results in $\mu\text{S}/\text{cm}$	Date
Minimum	269.5250	
Maximum	559.1000	
Mean	341.9877	
Median	317.6000	
2007-2009 Conductivity Results		
Susan Creek-Upstream (SNC2A)	Results in $\mu\text{S}/\text{cm}$	Date
Minimum	251.2	9/26/2007
Maximum	335.76	6/2/2009
Mean	286.78	
Median	281.56	

The baseline conductivity range is wide and has a higher maximum range than other warm water creeks with migration periods for salmon and trout.

4. Chloride

Table 4. 2001-2009 Chloride Results

Susan Creek-Downstream (SNC1)	Results in mg/L	Date
-------------------------------	---------------------------------	------

Minimum	5.0	5/31/2001
Maximum	34.8	7/24/2001
Mean	16.1	
Median	14.5	
2007 & 2009 Chloride Results		
Susan Creek-Upstream (SNC2A)	Results in mg/L	Date
Minimum	10.95	8/5/2009
Maximum	19.24	10/24/2007
Mean	13.726	
Median	13.325	

Chloride results are within the recommended range to support Tribal uses.

5. pH

Table 5. 2001-2009 pH Results

Susan Creek-Downstream (SNC1)	pH Results	Date
Minimum	7.97	10/24/2007
Maximum	8.28	8/5/2009
Mean	8.14	
Median	8.18	
Susan Creek-Upstream (SNC2A)	pH Results	Date
Minimum	7.84	5/4/2009
Maximum	8.29	8/5/2009
Mean	8.08	
Median	8.06	

Baseline pH results are within the recommended 6.5-9 pH units used for this assessment.

6. Total Phosphorus

Table 6. 2001-2009 Total Phosphorus Results

Susan Creek-Downstream (SNC1)	Results in µg/L	Date
Minimum	5.6	6/28/2005
Maximum	55.3	10/2/2003
Mean	12.85	
Median	10.55	
Susan Creek-Upstream (SNC2A)	Results in µg/L	Date
Minimum	2.4	10/24/2007
Maximum	14.1	8/5/2009
Mean	9.78	
Median	9.9	

Total phosphorus baseline mean and median results are within the range found in unpolluted waters. The maximum total phosphorus reading recorded at SNC1 in October of 2006 was the only exceedence reported during the baseline assessment. The month before this maximum result total phosphorus was still high but below the 50 µg/L. The following month concentrations were below the median and mean at this site. Therefore, these results are not of a concern since it is not reoccurring. Total phosphorus results at SNC2A have been fairly low in the two years that monitoring has been conducted.

7. Total Nitrogen

Table 7. 2001-2009 Total Nitrogen Results

Susan Creek-Downstream (SNC1)	Results in mg/L	Date
Minimum	0.397	9/20/2005
Maximum	1.26	6/28/2005
Mean	0.757	
Median	0.76	
2007 & 2009 Total Nitrogen Results		
Susan Creek-Upstream (SNC2A)	Results in mg/L	Date
Minimum	0.02	9/1/2009
Maximum	0.847	7/24/2007
Mean	0.686	
Median	0.789	

Baseline total nitrogen results are within the range suggested in this assessment to be found in unpolluted waters.

8. Total Suspended Solids (TSS)

Table 7. 2001-2009 TSS Results

Susan Creek-Downstream (SNC1)	Results in mg/L	Date
Minimum	1.33	8/30/2001
Maximum	12.18	6/26/2001
Mean	4.14	
Median	2.8	
Susan Creek-Upstream (SNC2A)	Results in mg/L	Date
Minimum	2.3	8/5/2009
Maximum	5.2	7/24/2007
Mean	3.83	
Median	4.15	

All baseline results for both sites are within the suggested range of 0-25 mg/L.

9. Discharge Rates

Velocity measurements are taken every year during monitoring events. See for results of 2009 depicting discharge calculations of the upstream (SNC2A) and downstream (SNC1) sites. See Figure 52. In 2005, SNC1 had dried up completely in August. In all other years monitored, the downstream site did not dry up but has seen minimal amounts of water within the stream channel. Illustrated by the chart you can see the flow decreased during the summer period at both sites and each site followed the same pattern in flow. Also, due to the small size of cross section width at both sites and less quantity of water in the stream channel in the summer, fewer readings were recorded to calculate discharge.

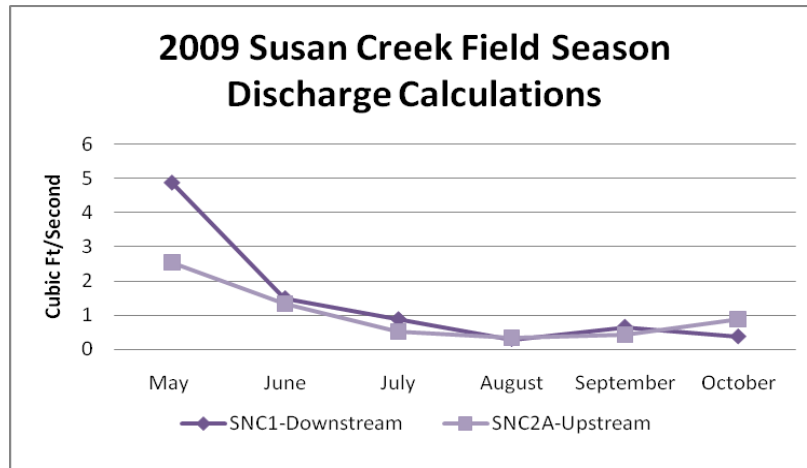


Figure 52: 2009 Susan Creek Field Season Discharge Calculations

10. Habitat Assessment

The low gradient habitat assessment conducted in 2009 at SNC1 had an overall rating of optimal habitat conditions. The overall score decreased from the score given in 2007 but only by a small percentage. The score in 2007 was also in the optimal category. This site is along the right of way of U.S Highway 31 North. It is between two private parcels owned by companies with industrial uses. The northern parcel is a shut down nuclear plant and the southern parcel is owned by a company that produces optical molds for the lighting industry. Since this stretch is on private property other than the area of the right of way the streambanks, the creek itself, and surrounding land remains undisturbed. Currently, the main concern for this area of the creek is runoff from the highway.

The low gradient habitat assessment conducted in 2009 at SNC2A had an overall rating of optimal habitat conditions as did the results of the 2007 assessment. This site is within the Little Traverse Conservancy parcel and fairly undisturbed. There is a culvert within this reach where an old railroad that no longer is in use or exists once ran through the property. This culvert has contributed to minimal channel alteration. The upstream property is mostly forested wetland and some agricultural land use. Riparian vegetation is dense and this site also experiences negligible human disturbance.

11. Macroinvertebrates

Macroinvertebrate data has been collected at three riffles at SNC1 throughout the years of the baseline study. Macroinvertebrates were not collected at SNC2A in 2007 due to the late addition of this site into the monitoring design, but one composite sample reflecting the reach was taken in 2009. Data is unavailable for the 2009 data collection for this report.

During the baseline study, riffles were compared year to year, and there were no significant increasing or decreasing trends found in any of the metrics. There was one observation: the percentage of Ephemeroptera, Plecoptera, and Trichoptera (EPT) present in the samples collected for all three riffles was at its highest during the baseline study in 2007. See Table 1 below.

Table 1.

Percentage EPT	R1	R2	R3
2001	18.27957	10.28037	15.07937
2003	5.454545	11.22449	7.070707
2005	13.48315	8.333333	14.28571
2007	39.3617	24.21053	18.51852

2007 also represented the lowest percentage of Chironomidae found in all riffles for all years monitored. See Table 2 below.

Table 2.

Percentage Chironomidae	R1	R2	R3
2001	40.86022	56.07477	26.19048
2003	89.09091	78.57143	60.60606
2005	23.59551	37.5	32.65306
2007	19.14894	15.78947	8.641975

E. Conclusion and/or Recommendations

This creek will continue to be monitored on a May-October monthly basis. This creek is one of only a few sites where EPA approved water quality standards and uses could be applied since it is LTBB trust land. Monitoring will continue at SNC2A and once five years of data has been collected it will be analyzed in the same manner as other sites have been in this baseline assessment. SNC1 will be eliminated due to better access upstream. LTBB surface water monitoring staff members have field checked a site upstream that is in the LTBB Taimi Hoag Natural Area where standards and uses could be applied in future. Monitoring at this new site will begin in May of 2011 and will include habitat and macroinvertebrate studies.

There has been great interest of the LTBB ESP programs to work with LTBB elder, Yvonne Walker, in gathering all cultural information that can be provided on this geographical area encompassing Susan creek and lake. LTBB WQS will contact Ms. Walker to organize a site visit that would entail walking the banks of the creek and learning more about the cultural significance of the creek.

The LTBB WQS has spoke with other NRD inland fisheries and wildlife staff about conducting a fish survey on Susan Creek. Due to current workloads and present commitments this cannot be completed until 2012 at the earliest. However, organization and dialogue will continue in order to collaborate on this type of data collection. Once this is completed a better understanding of what fish species inhabit and migrate into the creek will be known. These results may change the draft Tribal use to a different fishery classification which could then constitute a change in the degree of support from further evaluation to fully supported, not supported, or partially supported.

5. Big Sucker Creek

A. Site Description and Background

Big Sucker Creek is a perennial stream that originates from O'Neal Lake and flows into Lake Michigan. The creek is approximately 3.44 miles long and has one tributary that breaks off from the main tributary. This small stream is called Little Sucker Creek. The land surrounding Big Sucker Creek is owned by the State of Michigan. The creek is completely within the

Wilderness and O'Neal Lake State Park areas. The land cover is forested and forested wetland. The area in which the creek meanders is remote and undisturbed by human land use activities. The land is used by occasional recreational fisherman, nature enthusiasts such as hikers, campers, and birdwatchers, and primarily for habitat for indigenous aquatic life and wildlife.

There have been two active sites in the Big Sucker Creek watershed. One is at the headwaters (BSC1) directly downstream of the dam at O'Neal Lake. This site has been consistently monitored throughout the baseline study. Little Sucker Creek (BSC2) was monitored until 2007. This site was eliminated because of insufficient amount of data collected due to the tributary drying up during the summer months. Little Sucker Creek dried up every year with the exception of 2001 and also does not represent the mouth of Big Sucker Creek. However, in order to assess the data that has been collected at BSC2, the site will continue to be monitored every other year in the spring and fall in the same years as all other Big Sucker Creek watershed sites. In order to get a holistic depiction of Big Sucker Creek's water quality and ecosystem, a new site will be monitored at the mouth of Big Sucker Creek (BSC1B). This site is in a remote area and will require more than a mile hike with large equipment on rugged terrain. Therefore, LTBB WQ staff will strive to complete sampling but will not sample without two staff present for safety concerns.

B. Tribal Use and Management

The primary Tribal use for Big Sucker creek and any adjacent creeks or surface water surrounding the creek is indigenous aquatic life and wildlife. Other designated tribal uses include partial secondary contact recreational, cultural/ceremonial, and warm water fishery. This area is utilized by LTBB Tribal citizens for hunting, gathering, fishing, and traditional ceremonial uses.

The area surrounding BSC2 and BSC1B (starting in 2012) is listed in the Federal Register as a determined Environmental Protection Agency Critical Habitat area for Endangered and Threatened Wildlife and Plants. The piping plover uses this area as a nesting area and endangered plants such as Pitcher's thistle grow within this area.

C. 2009 Tribal Use Attainment

Since data was not collected on BSC2 in 2009 a degree of support will not be given. All parameters were within the recommended thresholds used in this assessment to determine a degree of support. Therefore, all uses are fully supported for the upstream portion of Big Sucker Creek, monitored at BSC1.

D. Parameter Results & Baseline Assessment

Little Sucker Creek has dried up in the summer months with the exception of 2001. Therefore, BSC2 data analysis is based on 20 data points whereas BSC1 analysis is based off of 34 data points. Winter sampling was not conducted at BSC2 in 2009 due to unavailable access.

1. Dissolved Oxygen

Table 1. 2001-2007 Dissolved Oxygen Results

Little Sucker Creek- Downstream (BSC2)	Results in mg/L	Date
Minimum	2.03	8/13/2003
Maximum	9.21	5/7/2003
Mean	5.99	
Median	6.88	

2001 & 2009 Dissolved Oxygen Results		
Big Sucker Creek-Upstream (BSC1)	Results in mg/L	Date
Minimum	6.65	8/9/2001
Maximum	11.01	5/2/2007
Mean	8.43	
Median	8.07	

As stated in the State of Michigan Water Quality Standards, the dissolved oxygen shall not be lowered below a minimum of 4 mg/L in waters of a warm water fishery. BSC2 has seen dissolved oxygen (DO) concentrations lower than 4 mg/L twice during the time of this study. The date of the minimum concentration for DO occurred at the same time as an extremely high total phosphorus concentration. Other low DO readings also occurred with higher total phosphorus concentrations, although, only the total phosphorus concentration reported on 8/13/2003 was above what is found in unpolluted waters. The Pearson Product moment correlation was performed on these two variables, and a correlation exists, demonstrating a decrease in dissolved oxygen when there is an increase in total phosphorus at BSC2. Note that these depletions of oxygen levels occur when there is little water within the creek bed also contributing to these lower concentrations. The upstream site, BSC1 has always been above the recommended DO concentration for a warm water fishery.

2. Temperature

Table 2. 2001-2007 Temperature Results

Little Sucker Creek- Downstream (BSC2)	Results in °C	Date
Minimum	9.26	10/9/2001
Maximum	25.6	8/13/2003
Mean	17.17	
Median	17.04	
2001 & 2009 Dissolved Oxygen Results		
Big Sucker Creek-Upstream (BSC1)	Results in °C	Date
Minimum	1.78	2/12/2009
Maximum	27.36	7/13/2005
Mean	19.14	
Median	20.8	

In order to assess temperatures for creeks with warm water fish only the definition of a warm water fishery was used as written in Appendix 1. This definition states “Warm water fisheries support fish able to tolerate monthly water temperatures not above 83F/28.3 °C”. Both sites never exceeded this suggested threshold temperature in this definition of a warm water fishery.

3. Conductivity

Table 3. 2001-2007 Conductivity Results

Little Sucker Creek- Downstream (BSC2)	Results in µS/cm	Date
Minimum	163.63	6/12/2003
Maximum	414.4	8/13/2003
Mean	272.15	

Median	256.34	
2001 & 2009 Conductivity Results		
Big Sucker Creek-Upstream (BSC1)	Results in $\mu\text{S}/\text{cm}$	Date
Minimum	29.41	6/1/2005
Maximum	344.31	2/12/2009
Mean	277.86	
Median	285.17	

The baseline conductivity range is wide for both sites with the lowest minimum concentration at BSC1. Similar to other water bodies monitored in the winter, the maximum conductivity reading for BSC1 was recorded during the winter sampling event as well. O'Neal Lake, where BSC1 is located, is in a remote area that does not have any adjacent roads that are salted in the winter. Access can only be attained by snowmobile. BSC2's maximum conductivity reading recorded occurred on the same day as the influx of total phosphorus and depletion of oxygen.

4. Chloride

Table 4. 2001-2007 Chloride Results

Table 4: 2001-2007 Chloride Results		
Little Sucker Creek- Downstream (BSC2)	Results in mg/L	Date
Minimum	1.11	6/1/2005
Maximum	6.9	10/9/2001
Mean	2.78	
Median	2.7	
2001 & 2009 Chloride Results		
Big Sucker Creek-Upstream (BSC1)	Results in mg/L	Date
Minimum	0.37	5/17/2001
Maximum	4.6	7/10/2003
Mean	2.93	
Median	2.84	

Chloride results are within the recommended range to support Tribal uses.

5. pH

Table 5. 2001-2007 pH Results

Little Sucker Creek- Downstream (BSC2)	pH Results	Date
Minimum	7.28	8/13/2003
Maximum	7.6	7/17/2001
Mean	7.46	
Median	7.490	
2001 & 2009 pH Results		
Big Sucker Creek-Upstream (BSC1)	pH Results	Date
Minimum	7.38	2/12/2009
Maximum	8.48	8/10/2005
Mean	8.22	
Median	8.26	

Baseline pH results are within the recommended 6.5-9 units used for this assessment.

6. Total Phosphorus

Table 6. 2001-2007 Total Phosphorus Results

Little Sucker Creek- Downstream (BSC2)	Results in µg/L	Date
Minimum	7.0	10/9/2001
Maximum	156.5	8/13/2003
Mean	29.65	
Median	18.5	
2001 & 2009 Total Phosphorus Results		
Big Sucker Creek-Upstream (BSC1)	Results in µg/L	Date
Minimum	4.4	2/12/2009
Maximum	23.5	6/4/2009
Mean	9.73	
Median	9.0	

Ranges are much wider at the lower site than at the upper site. This may be due to nutrients picked up in the upper stretches of wetland and algae growth in the stagnant surface water within the wetland. As mentioned in the dissolved oxygen section a correlation test was performed on these two variables and an inverse correlation exists. This inverse relationship is demonstrated by a decrease in dissolved oxygen when there is an increase in total phosphorus using the BSC2 baseline data set. The mean and median results for BSC2 are within what would be found in unpolluted waters. These influxes are not of concern due to this creek being intermittent with very little flow and water volume in the stream bed at the time, and it is the opinion of the LTBB WQS that these influxes are of natural origin from discharge of the upper wetland areas. BSC1 total phosphorus results have always been in the recommended range of what results depict unpolluted waters.

7. Total Nitrogen

Table 7. 2001-2007 Total Nitrogen Results

Little Sucker Creek- Downstream (BSC2)	Results in mg/L	Date
Minimum	0.00139	6/1/2005
Maximum	1.0910	6/7/2007
Mean	0.1432	
Median	0.0200	
2001 & 2009 Total Nitrogen Results		
Big Sucker Creek-Upstream (BSC1)	Results in mg/L	Date
Minimum	0.00139	10/5/2005
Maximum	0.7039	7/9/2007
Mean	0.2419	
Median	0.0650	

Baseline total nitrogen results are low and within the range suggested in this assessment to be found in unpolluted waters.

8. Total Suspended Solids (TSS)

Table 7. 2001-2007 TSS Results

Little Sucker Creek- Downstream (BSC2)	Results in mg/L	Date
Minimum	0.9	5/7/2003
Maximum	50.9	8/13/2003
Mean	8.173	
Median	2.28	
2001-2009 TSS Results		
Big Sucker Creek-Upstream (BSC1)	Results in mg/L	Date
Minimum	0.2	10/3/2007
Maximum	16.8	6/4/2009
Mean	2.53	
Median	1.75	

All baseline results for BSC1 are within the suggested range of 0-25 mg/L. BSC1 exceeded the recommended range twice during the baseline study. Both incidents were in 2003 in August and October, sharing the same date as the maximum concentration for total phosphorus and minimum concentration for dissolved oxygen. Rain was not reported on this monitoring day or the day before.

9. Discharge Rates

Velocity measurements are taken every year during monitoring events. However, only BSC1 results are available for 2009 since BSC2 was eliminated in 2007. Discharge calculations comparing the two sites have been submitted in previous water quality assessment reports. See Figure 53 to see the comparison of discharge calculations at BSC2 for every month velocity was taken at this site.

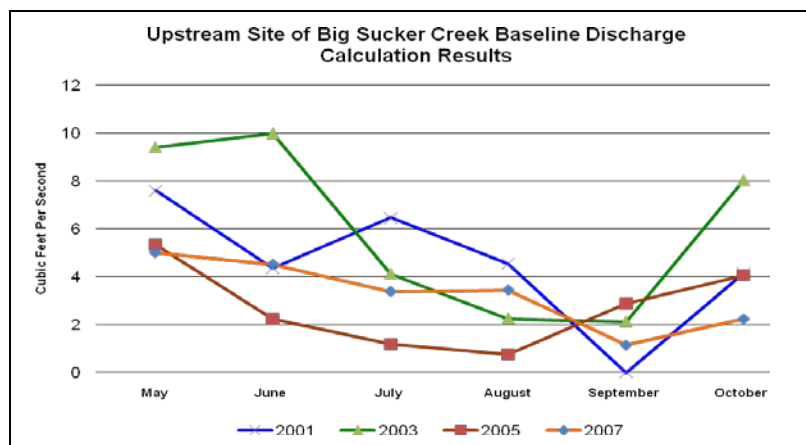


Figure 53: Upstream Site of Big Sucker Creek Baseline Discharge Calculation Results

In the spring through July, 2007 and 2005 flow readings have decreased compared to 2003 and 2001 readings. Most years follow a typical seasonal flow pattern for creeks. Increased flow in the spring decreases in the summer and then increases again in the fall.

10. Habitat Assessment

Low gradient habitat assessments conducted at the upstream site, BSC2, in 2009 and 2007 had an overall score of optimal conditions. The score in 2009 was slightly higher than the score given in 2007. The epifaunal substrate and/or available cover score was within the suboptimal category in 2007 and in the optimal category in 2009. In 2007, much of the substrate coverage such as snags and submerged logs new fall whereas, in 2009 it was fall from years such as 2007 offering full colonization potential. This site is located directly downstream of the spill way for the dam at O'Neal Lake.

Habitat assessments have not been conducted at Little Sucker Creek, BSC1. Habitat assessments are conducted in July when the creek is dried up therefore, an assessment is not applicable during this time.

11. Macroinvertebrates

Macroinvertebrates have been collected at both sites throughout the baseline assessment. 2009 macroinvertebrates have not been identified yet; therefore, only data collected between 2001-2007 will be discussed.

After assessing the riffle data at the Little Sucker Creek, no clear increase or decrease in perturbation can be concluded. Riffle 3 was the only riffle with trends; there is an increasing trend of the percentage of chironomids ($R^2=0.82$) and the overall diversity score ($R^2=0.77$). There is also a trend of the percentage of the dominant taxon decreasing over time. The dominant taxon in 2007 for all riffles was the family Chironomidae, genus *Orthocladius*.

Big Sucker Creek's (BSC1) headwaters data also had mixed results. Riffle 1 has an increase in the percentage of chironomids over the period of the baseline assessment. Riffle 2 had an increase of the dominant taxon over time and also saw a decrease in diversity over time.

2009 data will be used to assess whether or not these trends continue or new trends are found to indicate any changes in water quality based on macroinvertebrate data.

E. Conclusion and/or Recommendations

A new site directly at the mouth of the creek will be monitored and will be compared to the headwaters data. This new site, BSC2B will be monitored on the same day as BSC1 seasonally every other year beginning in 2012. This site is about one mile into a remote area on sandy terrain, so an evaluation of access will be concluded in the next water quality assessment report. As mentioned in the site description and background, BSC2 will only be monitored every other year during spring and fall when the creek still flows.

The WQS and Inland Fisheries and wildlife staff have collaborated in a water quality and fish data collection monitoring event in the past at the headwaters and will continue to make efforts to collaborate in the future on this water body. The WQS did not have the fish data for this field event at the time of the submission of this report. The LTBB WQS will include this data in the next water quality assessment report.

6. Brush Creek and West Branch of the Maple River

A. Site Description and Background

Brush Creek originates from Larks Lake and runs through the Pleasantview Swamp. Brush Creek runs southward where it connects into the west branch of the Maple River. The west branch of the Maple River and the east branch of the Maple River meet at Lake Kathleen. The

east branch originates from Douglas Lake. Kathleen Lake has an old power dam which is no longer in use. The Maple River flows southward until it discharges into Burt Lake.

There is one site on Brush Creek and two sites on the west branch of the Maple River. The Brush Creek site is located within the Pleasantview Swamp (BCMR3). The cross section of BCMR3 is approximately 5.5 meters. There is an upstream monitoring location on the west branch of the Maple River (BCMR2) with a cross section of approximately 11.3 meters. The downstream monitoring site (BCMR1) of the west branch is slightly upstream of Lake Kathleen and has a cross section of approximately 10.4 meters.

B. Tribal Use and Management

The LTBB draft primary use at BCMR3 is indigenous aquatic life and wildlife and draft designated uses include; warm water fishery and partial secondary contact recreational. The LTBB draft primary use at BCMR2 and BCMR1 is as a cold water fishery with draft designated uses of primary contact recreational, indigenous aquatic life and wildlife, and subsistence fishery.

C. 2009 Tribal Use Attainment

All uses at BCMR1 are fully supported. Temperatures exceed the referenced temperature thresholds for optimum rainbow trout spawning and embryo survival at both Maple River sites. The only exception was at BCMR2 in October where the temperature was below the recommended threshold for embryo survival. BCMR1 always had temperatures lower than the referenced threshold for optimum growth during monitoring events. BCMR2 exceeded optimum growth recommendations during the summer months of the baseline assessment, except in 2009. Dissolved oxygen readings at BCMR2 fell below the recommended 7 mg/L used for this assessment for cold water fish on four occasions, however the concentrations were never below 5.5 mg/L. BCMR2 was given a need for further evaluation for the use of cold water fishery, but all other uses are fully supported. BCMR3 also had DO reports lower than 4 mg/L for warm water fish on numerous occasions. This site is within full support of partial secondary contact recreational. It needs further evaluation for indigenous aquatic life and wildlife and warm water fishery. Since the Maple River is a continuous water system and fish can migrate to the main or east branch where temperatures are lower, these exceedences do not affect the degree of support. All other parameters are within the recommended threshold value for this assessment.

D. Parameter Results & Baseline Assessment

1. Dissolved Oxygen

Table 1. 2001-2009 Dissolved Oxygen Results

Maple River -Downstream (BCMR1)	Results in mg/L	Date
Minimum	7.73	7/1/2003
Maximum	10.7	5/16/2007
Mean	9.261	
Median	9.34	
Maple River-Upstream (BCMR2)	Results in mg/L	Date
Minimum	5.26	6/22/2001
Maximum	9.75	9/2/2009
Mean	8.13	

Median	8.2	
Brush Creek-Upstream (BCMR3)	Results in mg/L	Date
Minimum	1.08	8/7/2001
Maximum	9.73	10/18/2005
Mean	5.13	
Median	5.13	

BCMR1 had dissolved oxygen (DO) concentrations above 7 mg/L throughout the baseline survey during all monitoring events. BCMR2 had 4 events out of 38 monitoring readings where DO concentrations were below 7 mg/L. This low DO may not be an issue based on the abundant amount of cold water fish species found in this stretch of the river. The LTBB WQS will review the fish data when it is received to assess whether or not many cold water fish inhabit this stretch of the river. NRD inland fisheries staff completed fish surveys at this site but the data was not available at the time of this assessment to confirm the diversity of fish present at BCMR2. Therefore, BCMR2 will need further evaluation for cold water fishery use. BCMR3 needs further evaluation based on the DO readings being below 4 mg/L on numerous occasions. It is possible that the Sonde used to measure DO may have been immersed in flocculent substrate. This site is only accessible by canoe due to a soft sinking bottom, and has low visibility of the bottom of the creek.

2. Temperature

Table 2. 2001-2009 Temperature Results

Maple River -Downstream (BCMR1)	Results in °C	Date
Minimum	8.8	10/24/2001
Maximum	18.34	6/19/2007
Mean	14.16	
Median	14.11	
Maple River-Upstream (BCMR2)	Results in °C	Date
Minimum	8.49	10/24/2001
Maximum	23.91	8/6/2001
Mean	16.49	
Median	16.7	
Brush Creek-Upstream (BCMR3)	Results in °C	Date
Minimum	5.73	10/23/2003
Maximum	29.5	6/22/2001
Mean	16.21	
Median	15.97	

In order to assess temperatures for creeks with warm water fish the definition in terms of temperature for a warm water fishery was used as written in Appendix 1. This definition states “Warm water fisheries support fish able to tolerate monthly water temperatures not above 83F/28.3”. BCMR3 only exceeded this definition during one monitoring event which is when the maximum temperature was recorded on June 22 of 2001 (Table 2).

See Figure 54 for an illustration of the recommended optimum rainbow trout thresholds and monthly temperatures for every year recorded during the baseline assessment at BCMR1. The black line represents rainbow trout growth, the red line is for optimum spawning conditions, and green is for embryo survival.

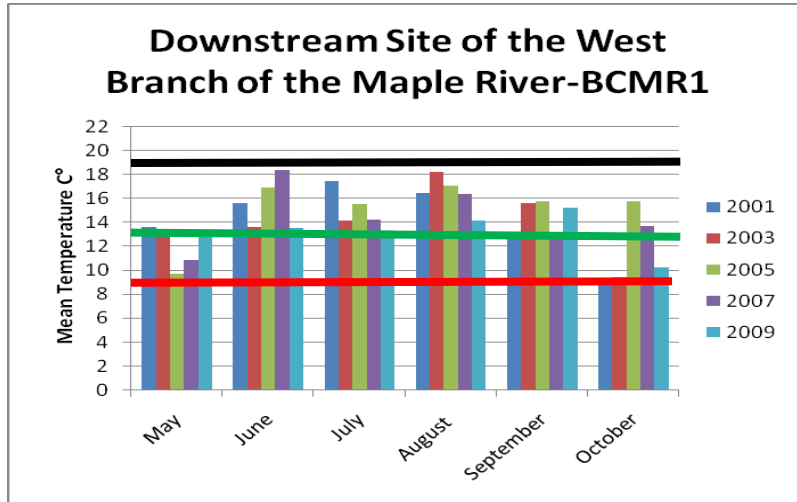


Figure 54: Downstream Site of the West Branch of the Maple River-BCMR1

Temperatures at BCMR1 were always below the maximum referenced threshold for optimum rainbow trout growth. During most fall and spring seasons temperatures were below the threshold for optimum embryo growth but always exceeded the recommended weekly average temperatures for optimum spawning conditions. See Figure 55 for an illustration of these thresholds represented by the same colored lines for BCMR2.

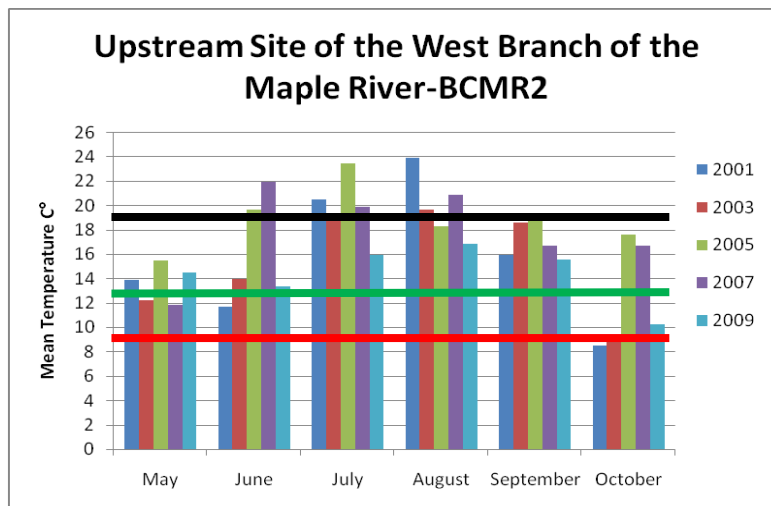


Figure 55: Upstream Site of the West Branch of the Maple River-BCMR2

Temperatures were below the recommended threshold for rainbow trout growth during the spring and fall of each year and during some summer seasons during various years as well. Temperatures for embryo growth exceeded during summer except in June of 2009 and varied in years during the summer and fall. Temperatures exceeded optimum spawning conditions consistently with the exception of October 2001 and 2003.

3. Conductivity

Table 3. 2001-2009 Conductivity Results

Maple River -Downstream (BCMR1)	Results in $\mu\text{S}/\text{cm}$	Date
Minimum	228.89	10/5/2009
Maximum	402.31	5/8/2003
Mean	309.68	
Median	316.4	
Maple River-Upstream (BCMR2)	Results in $\mu\text{S}/\text{cm}$	Date
Minimum	193.0	6/22/2001
Maximum	357.7	7/13/2005
Mean	297.97	
Median	313.0000	
Brush Creek-Upstream (BCMR3)	Results in $\mu\text{S}/\text{cm}$	Date
Minimum	196.0	6/11/2003
Maximum	327.8	9/18/2007
Mean	230.87	
Median	229.0	

The range of conductivity at all sites is similar to creeks and rivers with similar characteristics and uses. The downstream has a higher range than the upstream site which is to be expected.

4. Chloride

Table 4. 2001-2009 Chloride Results

Maple River -Downstream (BCMR1)	Results in mg/L	Date
Minimum	3.69	6/15/2005
Maximum	8.69	10/5/2009
Mean	5.9	
Median	5.77	
Maple River-Upstream (BCMR2)	Results in mg/L	Date
Minimum	0.01	5/24/2001
Maximum	8.12	10/5/2009
Mean	4.68	
Median	5.0	
Brush Creek-Upstream (BCMR3)	Results in mg/L	Date
Minimum	0.1	5/24/2001
Maximum	8.85	9/16/2009
Mean	4.296	
Median	4.08	

Baseline chloride results are low for all three sites monitored, fully supporting all Tribal uses. Chloride runoff based on these results for the sites on the west branch of the Maple River does not seem to be of a concern or an impact to this branch of the river. Although the chloride results are low at Brush Creek, there is a trend ($R^2=0.83$) that chloride concentrations have increased over the period of the baseline assessment. See Figure 56

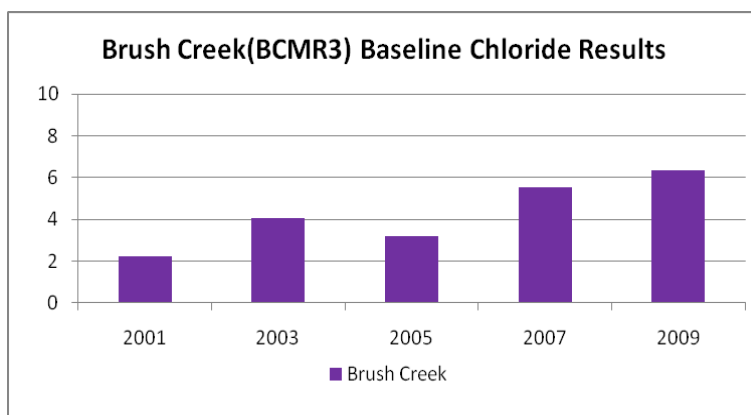


Figure 56: Brush Creek (BCMR3) Baseline Chloride Results

5. pH

Table 5. 2001-2009 pH Results

Maple River -Downstream (BCMR1)	pH units	Date
Minimum	7.55	7/1/2003
Maximum	8.28	7/2/2009
Mean	8.08	
Median	8.1	
Maple River-Upstream (BCMR2)	pH units	Date
Minimum	5.5	6/22/2001
Maximum	8.2	7/17/2007
Mean	7.781	
Median	7.84	
Brush Creek-Upstream (BCMR3)	pH units	Date
Minimum	6.9	10/19/2009
Maximum	7.8	9/16/2009
Mean	7.3	
Median	7.3	

Baseline results at BCMR1 and BCMR3 are within the State of Michigan's Water Quality Standards 6.5-9 range used for assessment. BCMR2 was reported outside this range on only one occasion as represented in Table 5 as the minimum result reported in June of 2001. Since this was the only pH data point reported outside of the recommended range and no significant trends were reported this low pH reading is not of a concern to water quality degradation.

6. Total Phosphorus

Table 6. 2001-2009 Total Phosphorus Results

Maple River -Downstream (BCMR1)	Results in µg/L	Date
Minimum	2.6	7/14/2005
Maximum	16.2	10/24/2001

Mean	9.37	
Median	9.1	
Maple River-Upstream (BCMR2)	Results in µg/L	Date
Minimum	5.0	7/13/2005
Maximum	20.7	6/22/2001
Mean	11.83	
Median	11.3	
Brush Creek-Upstream (BCMR3)	Results in µg/L	Date
Minimum	4.4	10/19/2009
Maximum	77.6	8/19/2003
Mean	19.9	
Median	16.7	

Baseline total phosphorus results for the west branch of the Maple River sites are within the reference range found in unpolluted waters. There is also a trend of total phosphorus decreasing over the period of the baseline assessment at both of these sites. Please see Figure 57.

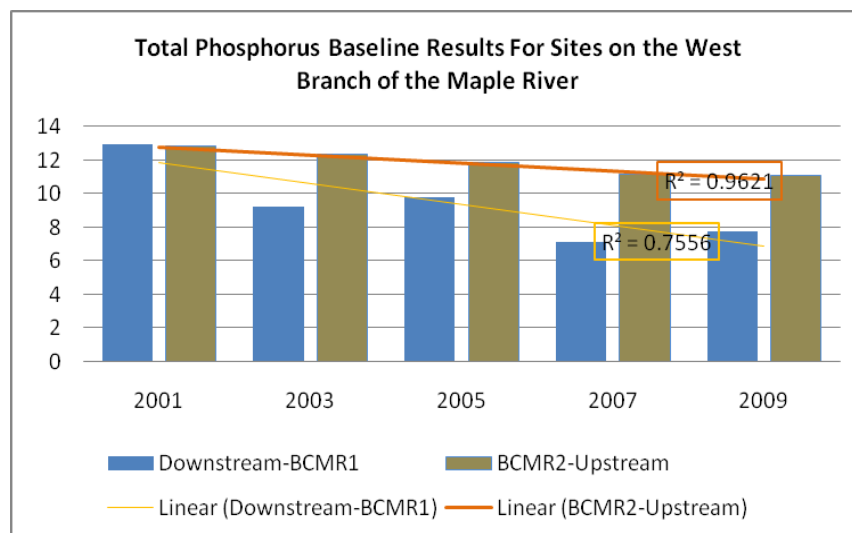


Figure 57: Total Phosphorus Baseline Results for Site on the West Branch of the Maple River

Brush Creek's maximum reported total phosphorus concentration was above the recommend range that would be found in unpolluted waters. The majority of readings taken were higher than the west branch river sites and the mean and median were in a higher range. Since the parameter does not indicate how much of this phosphorus is of natural occurrence it is unknown whether or not concentrations are of natural causes or excess nutrient runoff from non-point sources. However, there is also a trend of total phosphorus concentrations decreasing during the time of the baseline assessment. See Figure 58.

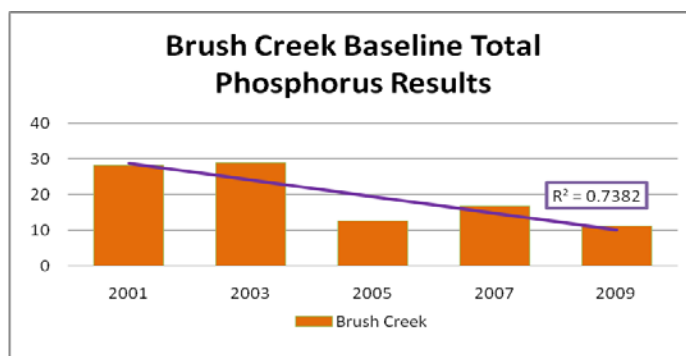


Figure 58: Brush Creek Baseline Phosphorus Results

7. Total Nitrogen

Table 7. 2001-2009 Total Nitrogen Results

Maple River -Downstream (BCMR1)	Results in mg/L	Date
Minimum	0.52	10/9/2007
Maximum	1.37	7/1/2003
Mean	0.73	
Median	0.67	
Maple River-Upstream (BCMR2)	Results in mg/L	Date
Minimum	0.36	5/8/2003
Maximum	1.42	7/1/2003
Mean	0.84	
Median	0.74	
Brush Creek-Upstream (BCMR3)	Results in mg/L	Date
Minimum	0.46	10/19/2009
Maximum	2.5	6/11/2003
Mean	0.96	
Median	0.81	

Total nitrogen baseline results for all sites are within the referenced range to be found in unpolluted waters and are all low concentrations.

8. Total Suspended Solids (TSS)

Table 7. 2001-2009 TSS Results

Maple River -Downstream (BCMR1)	Results in mg/L	Date
Minimum	0.3	9/4/2007
Maximum	6.9	5/16/2001
Mean	2.6	
Median	2.4	
Maple River-Upstream (BCMR2)	Results in mg/L	Date
Minimum	0.7	9/4/2007
Maximum	10.4	8/14/2003
Mean	2.35	
Median	1.8	

Brush Creek-Upstream (BCMR3)	Results in mg/L	Date
Minimum	0.5	5/17/2007
Maximum	34.1	8/19/2003
Mean	4.19	
Median	2.5	

Baseline TSS results are within the recommended range of 0-25 mg/L for the west branch Maple River sites. Brush Creek has one reported reading outside of this range. This data point is the maximum concentration reported in Table 7 in August of 2003. There are no trends indicating an increase in sediments in this area of the creek so this result is not considered an issue to water quality at this time.

9. Discharge Rates

Velocity measurements were taken at both sites during the 2009 field season on the west branch of the Maple River sites. Velocity was not taken at Brush Creek in 2009 since flow is minimal or absent. Both sites follow the same pattern during the 2009 field season. The downstream site has stronger flow resulting in higher discharge calculations which is expected based on the characteristic of the changes in cross section width and morphology of this river system. See Figure 59.

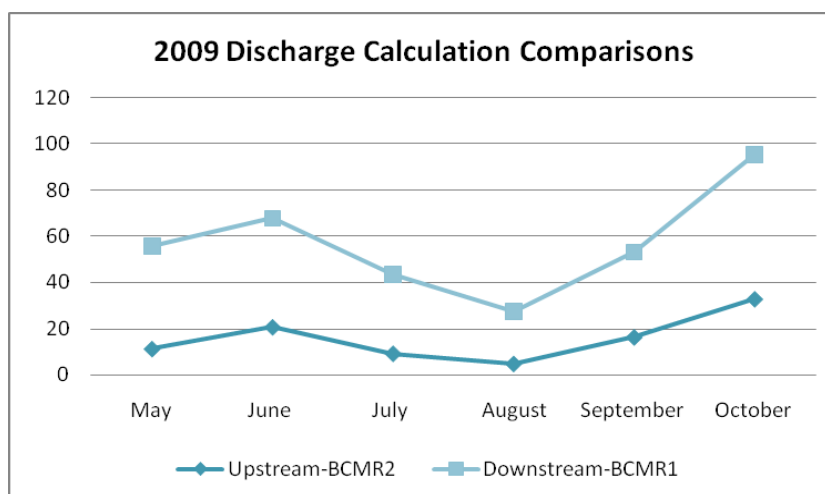


Figure 59: 2009 Discharge Calculation Comparisons

10. Habitat Assessments

High gradient habitat assessments completed at BCMR1 in 2007 and 2009 both had an overall score of optimal habitat conditions. The overall score was higher in 2009 due to some condition changes. Channel flow status had changed from suboptimal to optimal in 2009 with less channel substrate exposure compared to 2007. The channel alteration score was higher in 2009 but this higher score could be debated based on differing opinions. It would be the LTBB WQS opinion that the 2007 scoring would be the most appropriate even in 2009. This is one of issues with qualitative assessments based solely on observation and opinion of the assessor.

The low gradient habitat assessments completed in 2007 and 2009 both had an overall score in the optimal habitat condition range. 2009 had a higher score than 2007. Habitat parameters that reflected the most change were sediment deposition, channel flow status,

alteration and status. In 2007 more of the substrate was exposed and there was more bar formation observed. Channel alteration and flow status were given suboptimal scores in 2007 and given optimal scores in 2009. These characteristics did not change that dramatically over a two year period therefore, the difference in these scores is probably based on differing opinions of the assessors.

A habitat assessment was not completed in July of 2007 due to the creek being dried up at the time. A low gradient habitat assessment was completed in 2009 with an overall score of optimal conditions for habitat.

11. Macroinvertebrates

Macroinvertebrates have been collected at both sites throughout the baseline assessment. 2009 macroinvertebrates have not been identified yet; therefore, only data collected between 2001-2007 will be discussed.

When comparing riffle results from year to year for each metric calculated there were no trends indicating an increase or decrease of perturbation. See Table 11 below for all calculations for BCMR1 and BCMR2. BCMR1 has always had some EPT orders that are more sensitive to pollution and BCMR2 has had pollution-sensitive EPT orders in 2005 and 2007 at all riffle grabs.

Table 11. Macroinvertebrate Calculations for BCMR1 and BCMR2

Score		BCMR1				Score		BCMR2			
		2001	2003	2005	2007			2001	2003	2005	2007
	R1	2.18	2.658	2.53	2.79		R1	2.77	1.86	2.30	2.24
	R2	2.43	2.21	2.62	2.59		R2	2.78	2.19	2.59	2.61
	R3	2.58	2.34	2.51	1.82		R3		1.89	2.399	2.02
%EPT		BCMR1				EPT		BCMR2			
		2001	2003	2005	2007			2001	2003	2005	2007
	R1	27.27	43.14	33.96	46.15		R1	27.78	6.15	27.10	12.04
	R2	24.75	23.96	24.53	34.38		R2	0	1.56	2.94	5.66
	R3	21.10	22.11	37.84	12.61		R3		0	12.9	1
% Chironomids		BCMR1				% Chironomids		BCMR2			
		2001	2003	2005	2007			2001	2003	2005	2007
	R1	41.41	11.76	38.68	34.6		R1	38.1	78.46	56.07	70.37

					2						
	R2	29.7 0	16.6 7	33.96	43 .1 3		R2	58.6 2	46.88	71.57	52.8 3
	R3	61.4 7	57.8 9	39.19	82 .8		R3		40	45.16	84
Dominant Taxa		BCMR1				Dominant Taxa		BCMR2			
		200 1	200 3	200 5	2007			2001	20 03	2005	200 7
	R1	30.3 0	23.5 3	22.6 4	23.0 8		R1	15.0	52. 31	40.19	47.2 2
	R2	38.6 1	46.8 8	28.3 0	24.3 8		R2	13.7	32. 8	28.43	18.8 8
	R3	20.1 8	32.6 3	22.9 7	58.5 6		R3		22. 86	19.356	49
%Hydropsychi dae		BCMR1				%Hydropsychi dae		BCMR2			
		200 1	200 3	2005	20 07			200 1	2003	2005	200 7
	R1	37.5	9.09	0	16 .6 7		R1	100	0	100	0
	R2	30.7 7	7.14 3	7.143	8. 11		R2	0	0	0	0
	R3	10	25	27.27	0		R3		0	100	0

Brush Creek grab samples are taken at two different substrate types: muck/mud and vegetative substrate. These grabs are combined when calculating metrics. 2007 had the lowest diversity score and the lowest percentage of chironomids. Ephemeroptera, Trichoptera, and Plecoptera (EPT) orders have never been present in the grab samples. EPT orders are not expected to be found at this site due to lower oxygen levels, stagnant water, minimal flow, and intermittency of the creek. The only trend indicated for the baseline macroinvertebrate data was a decrease in the percentage of one dominant taxa each year. See Figure 60.

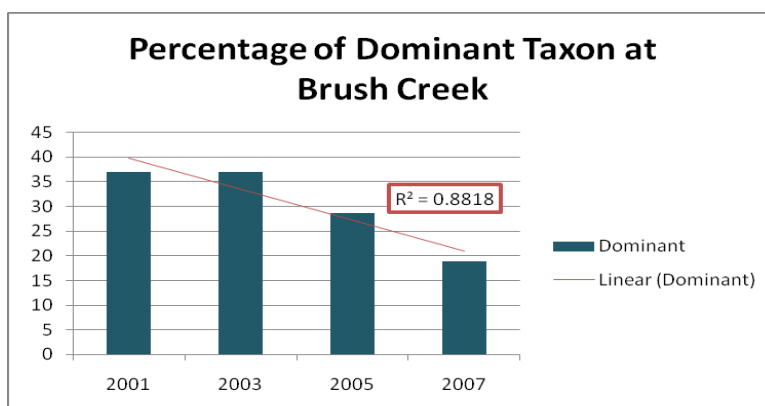


Figure 60: Percentage of Dominant Taxon at Brush Creek

E. Conclusion and/or Recommendations

In 2011, Brush Creek was eliminated from the monitoring design. The inconsistency of monitoring due to the creek drying up and the characteristics of this site justified the elimination. BCMR3 is stagnant water and part of the Pleasantview Swamp. Since Brush Creek is an integral part of this diverse wetland, other studies and assessment using wetland methodologies may be more appropriate in this area. When the baseline assessment began, our Wetland Protection Program had not been established. The LTBB WQS will meet with the Wetland Specialist to discuss possible surveys that would be appropriate for this area.

As mentioned in this summary, the LTBB WQS will meet with LTBB Inland Fisheries and Wildlife staff to discuss fish survey results conducted in the upper stretches of the west branch of the Maple River and any other wildlife assessed. This will allow for a degree of support to be established at BCMR2 and may cause a change in fishery classification.

The LTBB WQS would also like to meet with a LTBB Elder, Historian, and/or Archives staff on significance of the creek and the river to Tribal citizens to make sure the proper draft Tribal uses have been applied to ensure the protection of water quality for Tribal Citizens.

7. Bear River

A. Site Description and Background

The Bear River is the largest river in length that LTBB monitors and is the largest tributary of Little Traverse Bay. The Bear River is approximately 14.6 miles long. The Bear River originates at Walloon Lake and flows into Little Traverse Bay. There is a well known trout creek, Springbrook Creek that flows into the upper stretch of the river. The last mile of the Bear River's length through the City of Petoskey contains the steepest drop of any river in Michigan's Lower Peninsula. The geographical area was formed by glaciers and beneath the river are large limestone beds.

The City of Petoskey, where the mouth of the river flows into Little Traverse Bay, was once named Bear River. The Odawa Tribes would and still utilize the river and surrounding land area for fishing, gathering medicines, food, and fruits, and hunting. The Bear River received its name based on the dense population of bear living near the river. The Odawa people used to hunt bear throughout the river's land base. Residents of the City of Petoskey, historically known as Bear River, relied heavily on the Bear River for industry and energy purposes. There were once seven dams on the river, providing power to grist and lumber mills and supplying the city and the surrounding community with electricity.

There were three sites monitored on the Bear River during the baseline assessment. BR1 is near the mouth of the river and upstream from the old hydroelectric dam. This dam now serves as a lamprey control structure. The cross section width of BR1 was approximately 12.8 meters during the baseline assessment. BR2 is approximately half way between the mouth and the headwaters. The cross section width of BR2 is approximately 14.6 meters. BR3 is located 2.35 miles downstream of the headwaters of the river. The cross section width of BR3 is approximately 8.6 meters.

B. Tribal Use and Management

The LTBB draft primary use for BR1 is a cold water fishery. BR2 and BR3 have a draft primary use of a warm water fishery with principal migratory routes for anadromous salmonids. Other Tribal uses at all sites include primary contact recreational, indigenous aquatic life and wildlife, cultural and ceremonial uses and subsistence fishery at BR1 only. The Bear River was the most used river by Tribal citizens according to the results of the Tribal uses questionnaire given at the 2008 LTBB community meeting. Tribal uses rated the highest on the Bear River were cultural, ceremonial and fishing.

The Bear River is listed as a Designated Trout Stream and is managed for trout under the authority Section 48701 by the Michigan Department of Natural Resource and the Environment (MDNRE). Every April from 2009-2011 the MDNRE has stocked over 5,000 rainbow trout in the downstream stretch where BR1 is located. 1000 brown trout were stocked in April of 2011 upstream of BR1 but below BR2.

The City of Petoskey incorporates the Bear River into the City of Petoskey Master Plan. Protection of the water quality of this river is one of the goals of the master plan and mentions stream bank erosion and storm water runoff as potential sources of pollution.

Tip of the Mitt Watershed Council has compiled all data collected over the years by all sources on the Bear River into one data sheet that will be shared continuously with the City of Petoskey in order to reach their goal of maintaining and protecting water quality as mentioned in the City's master plan.

C. 2010 Tribal Use Attainment

Temperatures exceeded optimum recommended rainbow trout growth thresholds in the summer months at BR1 and only in July at BR2 and BR3. Optimum spawning conditions were exceeded during each month monitored during the field season at BR1 and every month during the field season except in October for BR2 and BR3. Optimum conditions for embryo survival were exceeded during each month of the field season except for October at BR1 and all months except September and October for BR2 and BR3. All other parameters at all sites were within the recommended thresholds used in this assessment. In 2010, MDNRE staff conducted a fish survey in June of 2010 in response to the Bear River Recreation permit submission. The Fisheries Management Biologist reported fish populations that were very impressive with large numbers of wild steelhead (several different year classes) in the reach of BR1, along with some Chinook salmon (most were suspected to have already migrated out). Once upstream of BR1 the salmonid catch diminished greatly. A wild steelhead population such as what is found at BR1 is rare. With the consideration of these findings and all other parameters being within their referenced thresholds, BR1 is given a full degree of support for all Tribal uses assigned. Since 2010 temperature results were generally higher downstream (BR1) than both upstream sites and all other parameters were supported for assigned uses, BR2 and BR3 are also given full degrees of support.

D. Parameter Results & Baseline Assessment

Note: Winter sampling is only conducted on BR1 due to access and ice cover issues at BR2 and BR3.

1. Dissolved Oxygen

Table 1. 2000-2010 Dissolved Oxygen Results

Bear River -Downstream (BR1)	Results in mg/L	Date
------------------------------	-----------------	------

Minimum	7.04	5/23/2002
Maximum	15.28	2/18/2010
Mean	9.79	
Median	9.46	
Bear River-Mid-stretch (BR2)	Results in mg/L	Date
Minimum	5.95	6/19/2002
Maximum	11.32	10/22/2010
Mean	8.4	
Median	8.29	
Bear River-Upstream (BR3)	Results in mg/L	Date
Minimum	7.19	6/14/2004
Maximum	11.99	9/16/2008
Mean	9.49	
Median	9.33	

Dissolved oxygen (DO) concentrations at BR1 during the baseline assessment have always been above 7 mg/L. BR2 and BR3 were also above the recommended 5 mg/L for a warm water fishery with migratory routes for anadromous salmonids.

2. Temperature

Table 2. 2000-2010 Temperature Results

Bear River -Downstream (BR1)	Results in °C	Date
Minimum	0.12	2/18/2010
Maximum	26.23	7/16/2002
Mean	16.34	
Median	16.53	
Bear River-Mid-stretch (BR2)	Results in °C	Date
Minimum	5.65	10/22/2002
Maximum	22.7	5/30/2006
Mean	16.03	
Median	16.95	
Bear River-Upstream (BR3)	Results in °C	Date
Minimum	6.01	10/22/2002
Maximum	21.69	7/1/19/10
Mean	14.99	
Median	16.11	

The mean and median temperatures at BR1, BR2, and BR3 are below the referred temperature threshold for optimum growth of rainbow trout but above the threshold values for optimum spawning conditions and embryo survival. However, when considering the State of Michigan fish assessment the fish species do not seem to be affected by these exceedences at least in the proximity of BR1. See Figure 61 for an illustration of the temperature patterns and thresholds at BR1. The black line represents rainbow trout growth, the red line is for optimum spawning conditions, and green is for embryo survival.

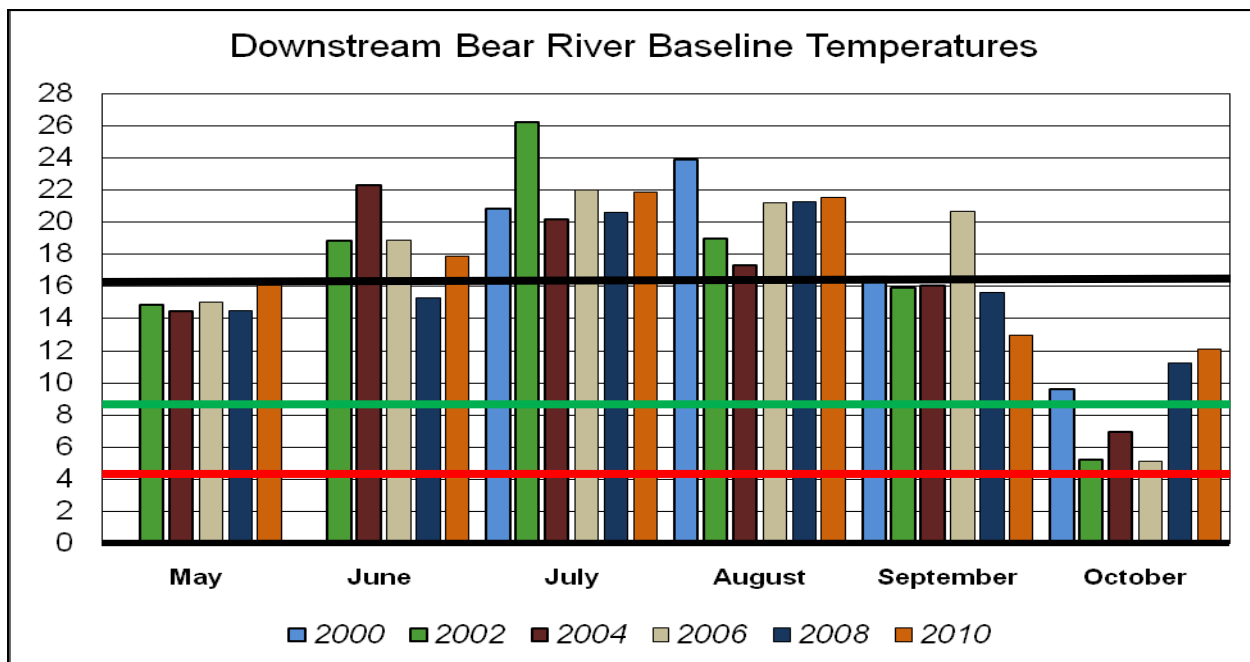


Figure 61: Downstream Bear River Baseline Temperatures

BR2 and BR3 have comparable means and medians to BR1, although temperatures decrease slightly, progressing to the monitoring sites upstream. See Figure 62. (BR2) and Figure 63. (BR3).

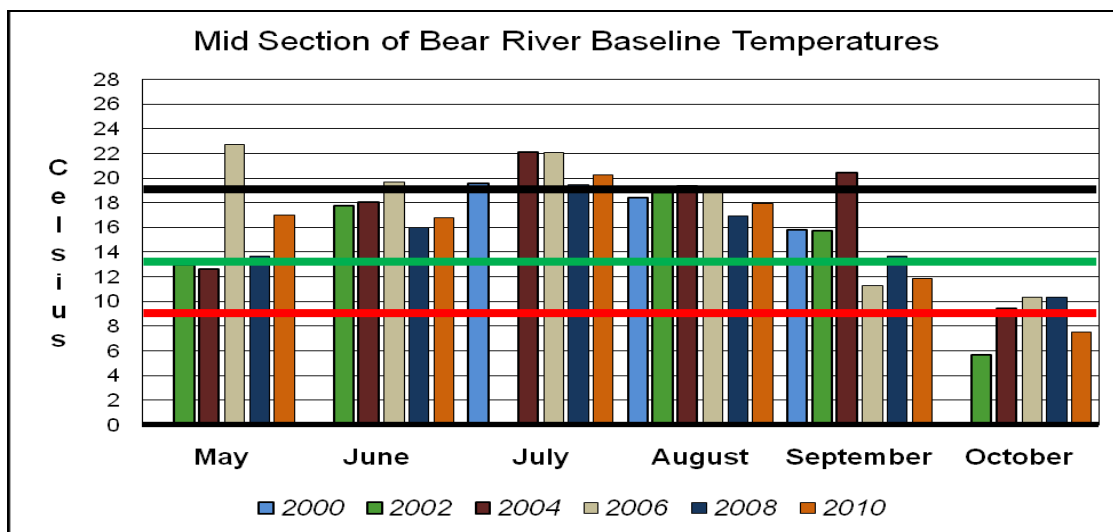


Figure 62: Mid-Section of Bear River Baseline Temperatures

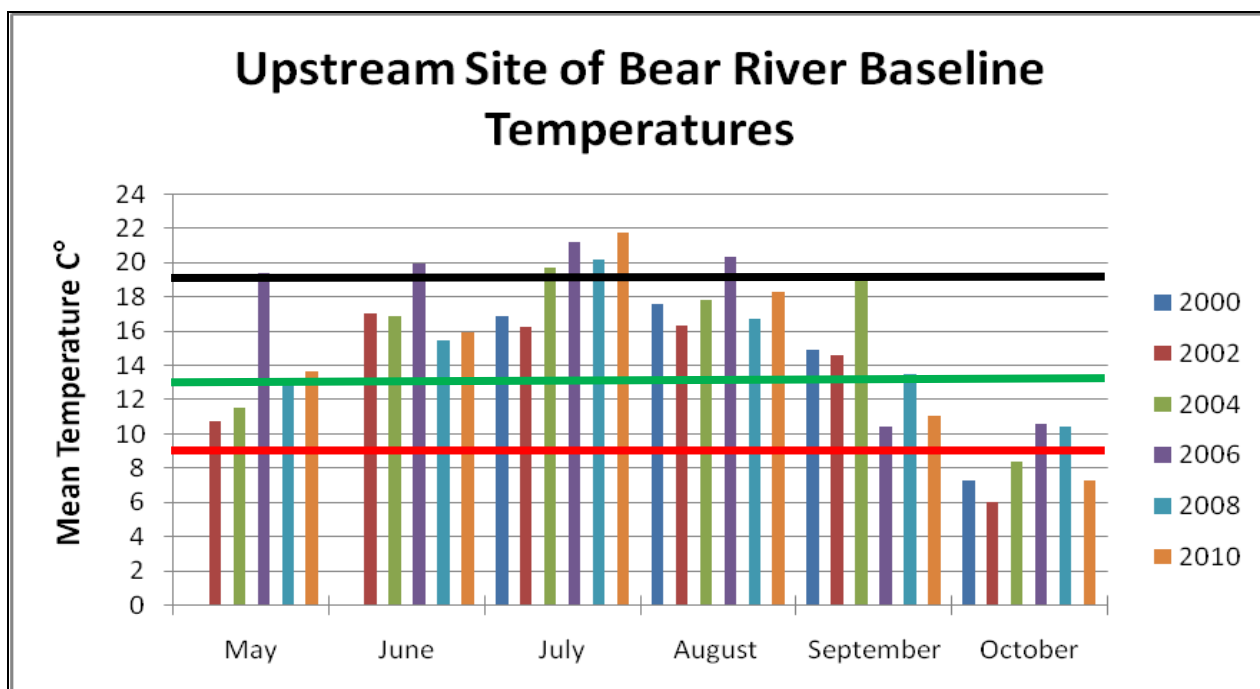


Figure 63: Upstream Site of Bear River Baseline Temperatures

3. Conductivity

Table 3. 2000-2010 Conductivity Results

Bear River -Downstream (BR1)	Results in $\mu\text{S}/\text{cm}$	Date
Minimum	256.5	10/18/2004
Maximum	412.39	10/10/2008
Mean	359.39	
Median	365.5	
Bear River-Mid-Stretch (BR2)	Results in $\mu\text{S}/\text{cm}$	Date
Minimum	246.8	5/27/2004
Maximum	397.53	10/16/2008
Mean	344.88	
Median	346.99	
Bear River -Upstream (BR3)	Results in $\mu\text{S}/\text{cm}$	Date
Minimum	271.34	5/27/2004
Maximum	392.03	10/15/2008
Mean	341.29	
Median	340.91	

The range of conductivity at all sites is similar to rivers with similar characteristics and uses. The downstream has a higher range than the upstream site which is expected.

4. Chloride

Table 4. 2000-2010 Chloride Results

Bear River -Downstream (BR1)	Results in mg/L	Date
------------------------------	-----------------	------

Minimum	8.0	5/17/2004
Maximum	35.13	2/26/2008
Mean	13.99	
Median	12.1	
Bear River-Mid-stretch (BR2)	Results in mg/L	Date
Minimum	4.94	8/14/2006
Maximum	13.86	7/24/2008
Mean	8.4	
Median	8.05	
Bear River-Upstream (BR3)	Results in mg/L	Date
Minimum	5.43	8/14/2006
Maximum	12.20	6/17/2008
Mean	8.13	
Median	8.1	

Baseline chloride results are fully supporting all Tribal uses. The mean and median as well as the range are higher at the downstream site. Chloride concentrations at BR1 have increased over the time of the baseline assessment (Figure 64). This site is downstream of the City of Petoskey and the Bear River Bridge where the river has increased potential for salt runoff from paved surfaces.

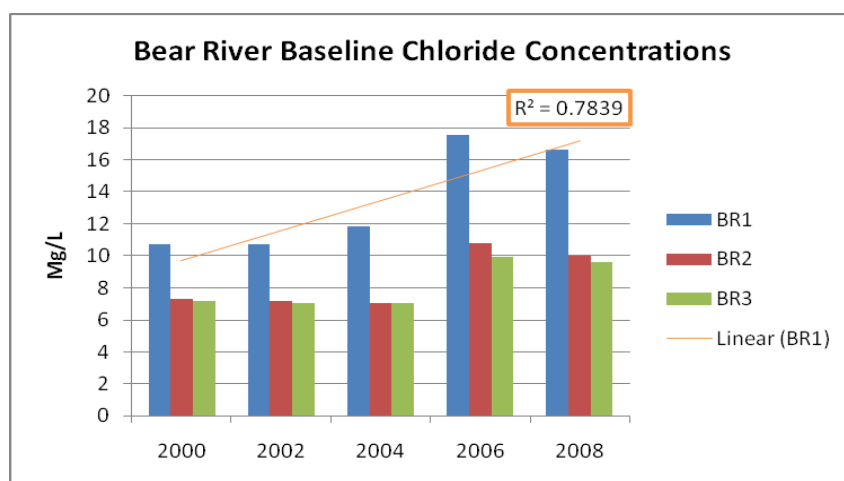


Figure 64: Bear River Baseline Chloride Concentrations

5. pH

Table 5. 2000-2010 pH Results

Bear River -Downstream (BR1)	pH units	Date
Minimum	7.11	2/26/2008
Maximum	8.47	8/19/2010
Mean	8.09	
Median	8.14	
Bear River-Mid-stretch (BR2)	pH units	Date
Minimum	7.44	6/14/2004

Maximum	8.78	9/17/2002
Mean	7.95	
Median	7.97	
Bear River-Upstream (BR3)	pH units	Date
Minimum	7.22	10/22/2002
Maximum	8.42	7/15/2004
Mean	8.01	
Median	8.03	

Baseline results at all Bear River sites are within the State of Michigan's Water Quality Standards 6.5-9 range used for assessment.

6. Total Phosphorus

Table 6. 2000-2010 Total Phosphorus Results

Bear River -Downstream (BR1)	Results in µg/L	Date
Minimum	3.5	5/14/2008
Maximum	35.7	5/25/2006
Mean	13.28	
Median	13.30	
Bear River-Mid-stretch (BR2)	Results in µg/L	Date
Minimum	0.8000	10/22/2010
Maximum	24.0000	6/14/2004
Mean	10.57	
Median	9.9	
Bear River -Upstream (BR3)	Results in µg/L	Date
Minimum	0.59	10/22/2010
Maximum	28.0	6/14/2004
Mean	7.84	
Median	7.15	

Baseline total phosphorus results are within the range found in unpolluted waters. BR1 has a higher minimum and maximum concentration, mean, and median, than the two upstream sites due to higher impact of human disturbance. However, there has been a trend of yearly average total phosphorus concentrations decreasing over the period of the baseline assessment. See Figure 65.

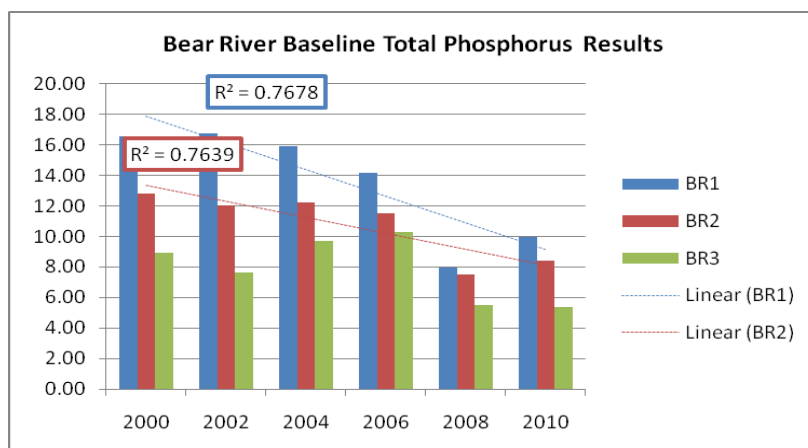


Figure 65: Bear River Baseline Total Phosphorus Results

7. Total Nitrogen

Table 7. 2000-2010 Total Nitrogen Results

Bear River -Downstream (BR1)		Results in mg/L	Date
Minimum		0.21	5/20/2010
Maximum		1.68	5/14/2008
Mean		0.57	
Median		0.51	
Bear River-Mid-stretch (BR2)		Results in mg/L	Date
Minimum		0.21	5/19/2010
Maximum		0.90	6/14/2004
Mean		0.51	
Median		0.51	
Bear River-Upstream (BR3)		Results in mg/L	Date
Minimum		0.1510	7/15/2004
Maximum		0.9963	5/31/2006
Mean		0.4226	
Median		0.4334	

Total nitrogen baseline results for all sites are within the referenced range found in unpolluted waters and are all low concentrations.

8. Total Suspended Solids (TSS)

Table 7. 2000-2010 TSS Results

Bear River -Downstream (BR1)		Results in mg/L	Date
Minimum		0.80	10/13/2010
Maximum		77.26	8/1/2000
Mean		9.33	
Median		6.9	
Bear River-Mid-stretch (BR2)		Results in mg/L	Date
Minimum		0.8	9/27/2010
Maximum		9.0	7/25/2000

Mean	4.13	
Median	3.76	
Bear River-Upstream (BR3)	Results in mg/L	Date
Minimum	0.68	9/20/2000
Maximum	7.6	6/14/2004
Mean	2.39	
Median	2.09	

Baseline TSS results are within the recommended range of 0-25 mg/L at all sites except on one occasion at BR1, which is the maximum concentration reported. BR1 has the widest range and a higher mean and median than the upstream sites. However, TSS results are fairly low considering the size, flow, and runoff potential of this river.

9. Discharge Rates

Velocity measurements were taken at all sites during the 2010 field season on the Bear River. BR2 and BR3 follow a similar pattern during the 2010 field season while BR1 fluctuates throughout the field season. BR1 also has higher peaks and stronger flow which is to be expected based on the steep drop within this section of the river. See Figure 66 for an illustration.

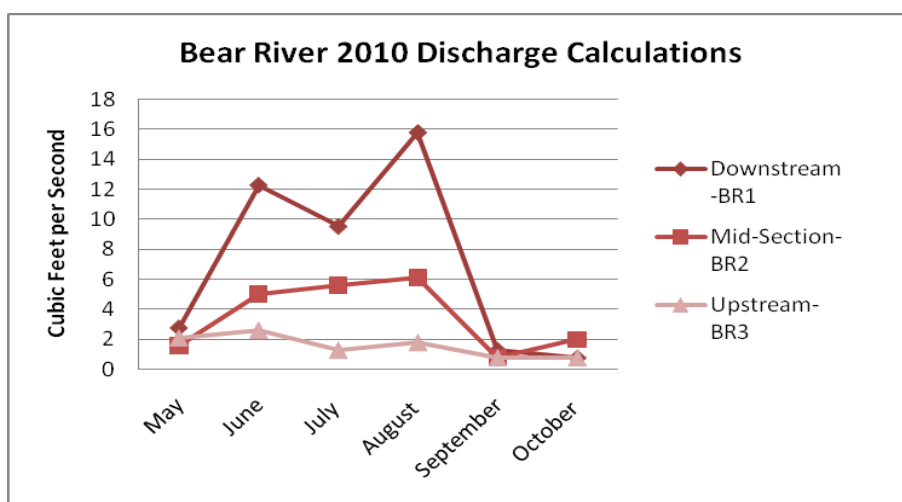


Figure 66: Bear River 2010 Discharge Calculations

10. Habitat Assessments

The Bear River high gradient habitat assessments performed in 2008 and 2010 both incurred an overall score within the optimal habitat conditions. The score in 2008 was slightly higher than the 2010 score. Habitat parameters that decreased the most were indicated in velocity depth regime, channel flow status, and channel alteration in 2010. These decreased scores may have been due to less water flowing through the channel than the previous year assessed.

The low gradient habitat assessments performed in 2008 and 2010 both indicated optimal habitat conditions at BR2. The score in 2008 was slightly higher than the overall score given in 2010. Conditions that decreased in score the most in 2010 were epifaunal substrate/available cover, pool substrate characterization, sediment deposition, and channel alteration.

The low gradient habitat assessments performed at BR3 in 2008 and 2010 both had overall scores indicating optimal conditions for habitat. In contrast to BR1 and BR2, BR3 had a higher score in 2010 than 2008. Increases were observed for pool variability, channel flow status and alteration, and channel sinuosity.

11. Macroinvertebrates

2008 macroinvertebrates identification and metric calculations have not been completed yet. The next water quality assessment report will include the analysis of these results. Trends have not been reported for years prior to 2008 except at the riffle downstream of the monitoring site at BR1. This riffle indicated a decrease in the diversity score from 2000-2006. Data from 2008 will be analyzed to indicate whether this trend has continued.

E. Conclusion and/or Recommendations

After the completion of baseline monitoring on the Bear River, field truthing was completed to add monitoring sites that were easier to access and have increased impact potential on degradation of water quality. BR2 and BR3 can only be accessed by canoe due to large pools that make areas of the river unwadeable. These sites will not be eliminated but will only be monitored in the spring and fall every other year. This will allow the data to be compared with baseline data collected during 2000-2010. BR4 is farther upstream than the baseline sites and directly downstream of the headwaters of the river. BR3A is a cross section below a road bridge chosen to measure whether or not the bridge impacts the river. The downstream site, BR1, will continue to be monitored on a seasonal basis every other year with BR4 and BR3A, and it will be monitored in the spring and fall every other year with BR3 and BR2. Data will be compared with baseline data to indicate whether or not there are changes in any water quality parameters due to in-river and river bank construction completed in 2010 to create white water for kayaking.

There were concerns during construction with implementation of best management practices while in river dredging was taking place based on observation during a construction event on August 19, 2010. This event was being completed to enhance the river rapids and surrounding park area. LTBB staff was monitoring the BR1 site and witnessed dredging in the river with the downstream turbidity curtain unattached to the stakes and large amounts of sediment draining down the river. A total suspended solids sample was taken downstream of the construction with a result of 36.8 mg/L. The engineer was notified of the issues and construction was halted and measures were taken to reinstall the turbidity curtain and compliance was enforced.

The LTBB WQS will discuss conducting fish surveys in the upstream stretches of the river in future years with the Inland Fisheries and Wildlife NRD staff to better indicate what temperatures thresholds are appropriate in this river.

Data will continue to be compiled by either TOMWC or LTBB and shared with the City of Petoskey since all entities share the same goal of protecting the water quality of the Bear River Watershed. Once the LTBB GLRI Bear River Habitat and Restoration Proposal activities have been completed by the LTBB Wetland Specialist and partners, the outcomes will be shared as part of future water quality assessments of this river.

8. Boyne River

A. Description and Background

The Boyne River is a cold water river system approximately 22 miles in length. This river is not within LTBB historical reservation boundaries, but it is adjacent to them. However, the river is part of the Lake Charlevoix watershed, which serves as part of the south boundary of the LTBB historical boundaries. The Boyne River has a drainage base of 40,320 acres and is the second-largest tributary draining into Lake Charlevoix.

The Boyne River is a well known cold water fishery with fish species such as chinook salmon, walleye, brook trout, brown trout, and rainbow trout inhabiting the river. During many of the spawning runs, LTBB monitoring was not completed due to the large presence of fisherman or fish spawning on or around LTBB sites.

The river has a mill pond, Boyne City Mill Pond, located about a mile upstream of Boyne City where the river drains into Lake Charlevoix. There is also a working hydroelectric dam upstream of the mill pond used by a local ski and resort business. Upstream where the south and north branch intertwine there is also an old dam built in the 1900's to power a saw mill and grist mill.

There are three sites monitored on the Boyne River. This river was not a part of the baseline assessment and was approved for monitoring as an amendment to the 106 Workplan Grant No. I975991010 on July 13, 2004. These sites were approved to be monitored seasonally every year for physical parameters only, limiting the cost to staff time, travel, and equipment use only. All three sites are within the main branch of the river. There is one site directly downstream of the old dam in Boyne Falls where the main branch begins. There is another mid section site downstream of a road bridge and culverts and is a well known spawning and fishing area. The last site is directly upstream of where the river discharges into Lake Charlevoix located in the city of Boyne.

B. Tribal Use and Management

The draft Tribal Use for the Boyne River is as a coldwater fishery. Other designated uses include primary contact recreational, subsistence fishery, and indigenous aquatic life and wildlife. LTBB citizens utilize this river to fish. There are sections of the river designated by the State of Michigan as Blue Ribbon Trout Streams. LTBB has supported the Friends of the Boyne River Inc. in past opposition to a permit that would allow discharge of waste water effluent into the Boyne River instead of its current discharge into Lake Charlevoix. This issue was the main catalyst for the Tribe to monitor the river. Water quality data will allow all stakeholders to determine whether or not future point or non-point sources, land use activities, or any other human disturbances are degrading water quality on this river.

C. 2009 and 2010 Tribal Use Attainment

Temperatures exceeded the referred optimum growth for rainbow trout at all sites during at least one of the 2009 and 2010 summer or spring monitoring events and also had exceedences for embryo survival and spawning conditions. Dissolved oxygen concentrations were always above 7 mg/L at all three sites. Although temperatures were above the recommended thresholds large numbers of coldwater fish species spawning in the river were observed by LTBB water quality staff. Therefore, all Tribal uses are assigned a degree of full support.

D. Parameter Results

Results were analyzed for all data taken beginning in 2004 through 2010. The parameters monitored only include dissolved oxygen, temperature, pH, and conductivity.

1. Dissolved Oxygen

Table 1. 2004-2010 Dissolved Oxygen Results

Boyne River -Downstream (BNR1)	Results in mg/L	Date
Minimum	8.67	6/27/2007
Maximum	13.6	4/26/2006
Mean	11.49	
Median	11.43	
Boyne River-Mid-stretch (BNR2)	Results in mg/L	Date
Minimum	8.21	6/29/2005
Maximum	13.16	2/29/2008
Mean	10.76	
Median	10.7	
Boyne River-Upstream (BNR3)	Results in mg/L	Date
Minimum	9.18	6/27/2007
Maximum	17.92	11/18/2005
Mean	11.78	
Median	11.38	

Dissolved oxygen (DO) concentrations at all three sites during seasonal analysis have been above the State of Michigan's threshold value of 7 mg/L for the classification of a cold water fishery.

2. Temperature

Table 2. 2004-2010 Temperature Results

Boyne River -Downstream (BNR1)	Results in °C	Date
Minimum	0.45	2/21/2007
Maximum	23.16	5/27/2010
Mean	10.69	
Median	10.47	
Boyne River-Mid-stretch (BNR2)	Results in °C	Date
Minimum	0.56	2/29/2008
Maximum	20.7	7/26/2007
Mean	9.86	
Median	10.2	
Boyne River-Upstream (BNR3)	Results in °C	Date
Minimum	0.17	2/29/2008
Maximum	20.84	6/25/2008
Mean	9.57	
Median	8.99	

The baseline mean and median temperatures at all three Boyne River sites are below the referred temperature threshold for optimum growth and embryo survival of rainbow trout but above the threshold values for optimum spawning conditions except at BNR3 for the median result. However, these mean and median are the coolest of river sites. To review an illustration of

temperature range based on monitoring season averages please see Figure 67 for BNR1, Figure 68 for BNR2, and Figure 69 for BNR3. The black line represents rainbow trout growth, the red line is for optimum spawning conditions, and green is for embryo survival.

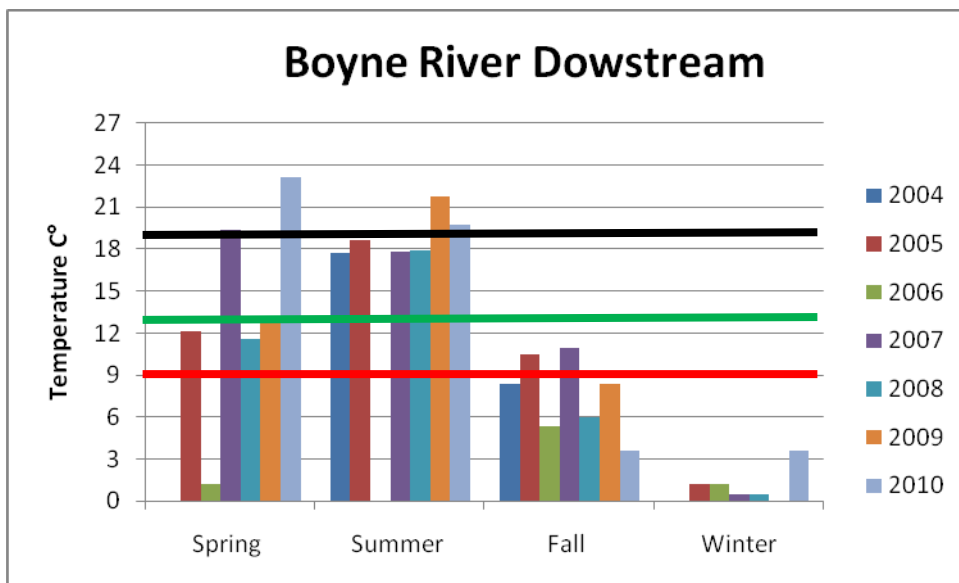


Figure 67: Boyne River Downstream

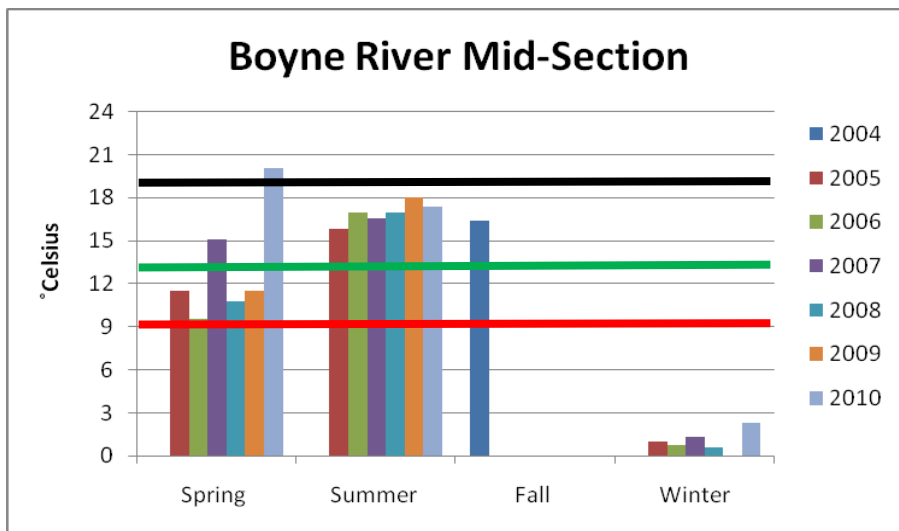


Figure 68: Boyne River Mid-Section

Data is not taken at this site when salmon are spawning in and near the cross section chosen for monitoring. Therefore, there is a lack of data for fall events.

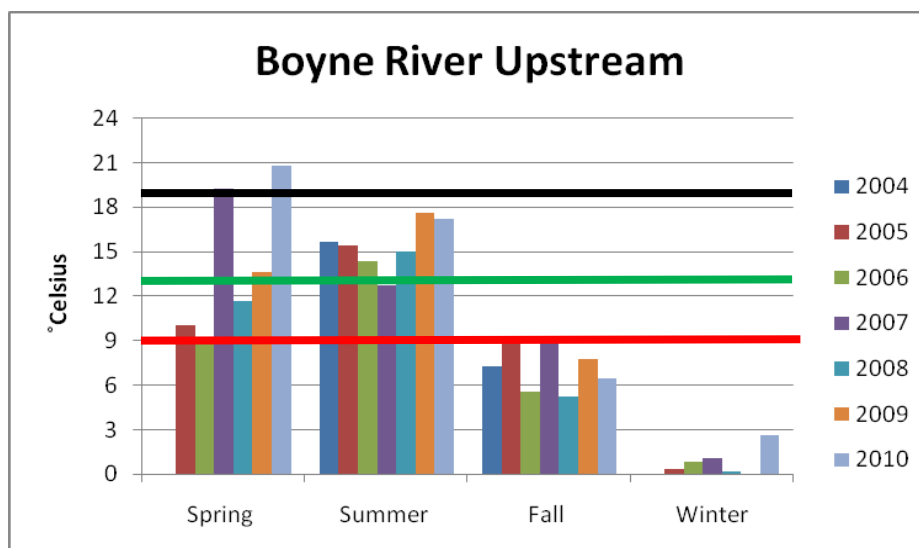


Figure 69: Boyne River Upstream

3. Conductivity

Table 3. 2004-2010 Conductivity Results

Boyne River -Downstream (BNR1)	Results in $\mu\text{S}/\text{cm}$	Date
Minimum	331.49	12/19/2006
Maximum	442.08	10/19/2005
Mean	405.06	
Median	410.71	
Boyne River-Mid-Stretch (BNR2)	Results in $\mu\text{S}/\text{cm}$	Date
Minimum	304.77	12/19/2006
Maximum	429.0	12/18/2007
Mean	387.07	
Median	392.6	
Boyne River -Upstream (BNR3)	Results in $\mu\text{S}/\text{cm}$	Date
Minimum	308.8	1/23/2007
Maximum	430.4	10/19/2005
Mean	392.14	
Median	401.44	

The range of conductivity at all sites is what would be expected in a faster colder river.

5. pH

Table 5. 2004-2010 pH Results

Boyne River -Downstream (BNR1)	pH units	Date
Minimum	7.42	11/18/2005
Maximum	8.63	8/25/2010
Mean	8.08	
Median	8.12	

Boyne River-Mid-stretch (BNR2)	pH units	Date
Minimum	7.35	2/11/2005
Maximum	8.54	8/25/2010
Mean	8.07	
Median	8.1	
Boyne River-Upstream (BNR3)	pH units	Date
Minimum	7.24	4/22/2005
Maximum	8.77	2/24/2010
Mean	8.1	
Median	8.12	

Baseline results at all Boyne River sites are within the State of Michigan's Water Quality Standards 6.5-9 range used for assessment.

6. Discharge Rates

Velocity and discharge calculation data has been presented to Friends of the Boyne River, Inc. and in past water quality assessments up to 2007. Only 2010 data will be represented in the chart in Figure 70, due to sparseness in data collection in 2008 and 2009 due to spawning events.

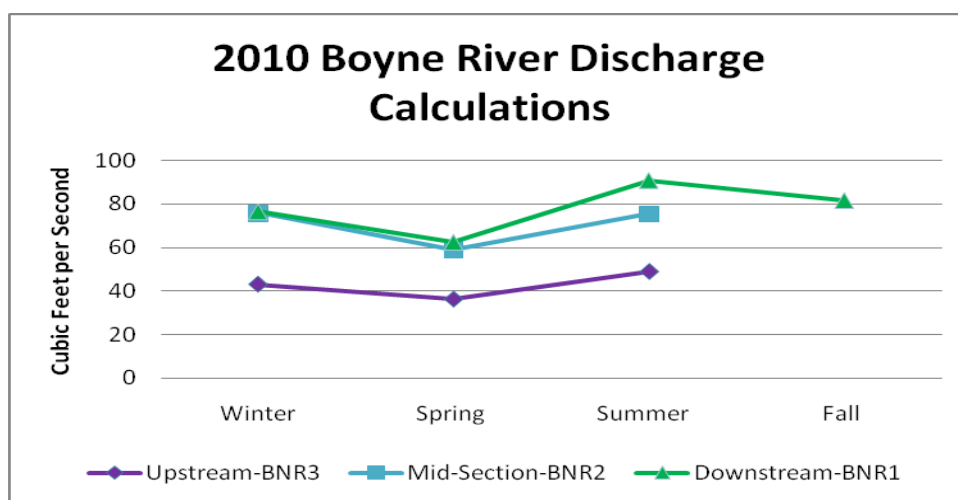


Figure 70: 2010 Boyne River Discharge Calculations

All sites follow the same seasonal pattern in discharge calculations with the downstream site depicting the strongest flow.

E. Conclusion and/or Recommendations

The Boyne River water quality analysis indicates that water quality is fully supporting all uses. The Boyne River will not be monitored during the next 106 workplan period. The LTBB WQS will meet with the Friends of the Boyne River, Inc. to summarize the data taken up to 2010 and discuss any needs in terms of water quality monitoring for the future. If the LTBB WQS feels these needs correspond with Tribal needs and goals then the LTBB WQS will incorporate these monitoring needs into a future workplan.

9. Baseline Conclusions

The completion of the baseline assessment allows the opportunity to utilize this data in the internal review and evaluation of the LTBB Surface Water Quality Protection Program. All waterbodies within the baseline assessment will continue to be monitored in order to assess future water quality conditions. However, duration, frequency, the addition and elimination of sites in the monitoring design will be based on Tribal water-body specific priorities and uses as well as the baseline conditions as stated in this assessment. The LTBB 106 Workplan (PPG grant # 96552404) includes the new monitoring design.

The Tribal draft uses utilized to assess water quality based on state, federal, and academic criteria will be discussed with the Environmental Services Coordinator, Natural Resource Director, Natural Resource Commission, and any other pertinent parties in order to establish whether or not the Tribe should move forward in seeking Tribal uses and/or Tribal Standards, create a Tribal water quality workgroup, Tribal lake management plans, and/or some other type of legislation to protect and sustain water quality. The LTBB WQS attended the EPA Region 5 Tribal Water Quality Standards Academy in June of 2011 and will share the information with the ESC and NRD and any others that they feel should be informed of the positives and negatives of moving in this direction. Water quality two year reports will still use the same format utilizing the draft uses and criteria until progression of water quality legislation or Tribal uses and standards move forward.

Parameters measured will comply with the Final Guidance on Award of Grants to Indian Tribes under Section 106 of the Clean Water Act. If any parameters within this guidance are not monitored through the LTBB surface water quality monitoring program, a justification of why it isn't will be documented in future workplans. LTBB may also measure other parameters in addition to the mandated parameters. For example, the LTBB NRD Wildlife program is experimenting with the growth of wild rice therefore, the LTBB WQS may add in sulfates, hardness, and substrate studies at these lakes where wild rice is being grown. Use attainment based on temperature criteria used for this baseline assessment seemed to be too stringent for LTBB waters. Use attainment was not supported if this was the only parameter exceedence. This was the sole judgment of the LTBB WQS and was a water body specific decision. This decision was based on past fish data and that the criterion uses was created in Alaskan waters. Long-term temperature studies may be discussed to be completed within future workplans to get a better determination of specific temperature thresholds.

The LTBB WQS will be working closely with the Little River Band of Ottawa and Chippewa Indians Aquatic Biologist, Stephanie Ogren in determining whether or not current metrics used to analyze macroinvertebrate data is sufficient for Tribal studies. Ms. Ogren is working on a Biological Index model that may compliment our current biological studies. Sites on lakes may change to the inlets and outlets and aquatic vegetation studies may also be pursued. Habitat assessments will still be completed but have proven to be fairly biased by the eye of the assessor and extremely qualitative. The LTBB WQS will implement quantitative pebble counts on creeks, streams, and rivers that have viable fisheries.

Since the baseline assessment began, technology has expanded. The LTBB Surface water quality monitoring program would like to purchase a Son Tek Flotracker to measure velocity and calculate discharge. The LTBB WQS attended a United States Geological Survey (USGS) training on the proper use and technical background of these velocity meters in December of 2010. This meter is USGS certified and provides errors and warnings whenever there are any issues with a velocity reading. This Flotracker could be utilized by other LTBB NRD staff as well. If the SonTek Flotracker is purchased, a comparison study may be done with the

mechanical pygmy meter and the Marsh McBirney Meter to evaluate how vast the accuracy can be between velocity meters.

The LTBB will continue to collaborate with other LTBB NRD programs and departments, other Tribal governments, state, local, and national entities. The LTBB WQS would like to have further conversations with the Archives, Records, and Repatriation staff on determining water body specific cultural/ceremonial significance and how to prioritize and preserve the water quality when related to cultural or ceremonial uses. The LTBB WQS will continue to work with the local watershed council, Tip of the Mitt Watershed Council, in an effort to eliminate duplication in our monitoring programs and increase partnerships when there are shared goals. All conclusion and recommendations will be followed up on and reported in the next water quality assessment two year report.

Data analysis and compilation used for this assessment will be used as an ongoing template for future data to be added onto. All data will still be formatted and uploaded into the EPA WQX/CDX database as well.

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